A COMPARATIVE EVALUATION OF SURFACE ROUGHNESS AND IMMEDIATE COLOUR STABILITY OF TWO NANOCOMPOSITES AFTER POLISHING WITH TWO DIFFERENT POLISHING SYSTEMS: AN *IN VITRO* STUDY

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The Tamil Nadu Dr M.G.R. Medical University

In partial fulfilment of the degree of

MASTER OF DENTAL SURGERY

BRANCH IV

CONSERVATIVE DENTISTRY AND ENDODONTICS

2014 – 2017

CERTIFICATE

This is to certify that this dissertation titled **"A comparative evaluation of surface roughness and immediate colour stability of two nanocomposites after polishing with two different polishing systems: an *in vitro* study"** is a bonafide record of the work done by **Dr. Rejoy Mathew John** under our guidance during his post graduate study during the period of 2014 - 2017 under **THE TAMIL NADU Dr. M.G.R MEDICAL UNIVERSITY, CHENNAI,** in partial fulfilment for the degree of **MASTER OF DENTAL SURGERY IN CONSERVATIVE DENTISTRY AND ENDODONTICS, BRANCH -IV**. It has not been submitted (partial or full) for the award of any other degree or diploma.

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This is to certify that the research project protocol, ***Ref no. 12/06/2015***titled, ***"A comparative evaluation of surface roughness and immediate colour stability of two nanocomposites after polishing with two different polishing systems – an in vitro study"*** submitted by ***Dr.Rejoy Mathew John, IIYear MDS, Department of Conservative Dentistry & Endodontics***has been approved by the Institutional Research Committee at its meeting held on 15th ***June 2015.***

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CERTIFICATE

This is to certify that the Research Protocol No. **SMIMS/IHEC/2015/A/17** entitled "A Comparative Evaluation of Surface Roughness and Immediate Color Stability of Two Nanocomposites after Polishing with Two Different Polishing Systems-An *In-vitro* Study" submitted by Dr. Rejoy Mathew John, Postgraduate of Department of Conservative Dentistry and Endodontics, SMIDS has been approved by the Institutional Human Ethics Committee at its meeting held on 15th December 2015.

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[This Institutional Human Ethics Committee is organized and is operating according to the requirements of ICH-GCP/GLP guidelines and requirements of the Amended Schedule-Y of Drugs and Cosmetics Act, 1940 and Rules 1945 of Government of India.]

DECLARATION

I hereby declare that this dissertation "**A COMPARATIVE EVALUATION OF SURFACE ROUGHNESS AND IMMEDIATE COLOUR STABILITY OF TWO NANOCOMPOSITES AFTER POLISHING WITH TWO DIFFERENT POLISHING SYSTEMS: AN IN VITRO STUDY**" is a bonafide record of work undertaken by me during the period 2014-2017 as a part of post graduate study. This dissertation, either in partial or in full, has not been submitted earlier for the award of any degree, diploma, fellowship or similar title of recognition.

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CONTENTS

SL No:	INDEX	PAGE NO
1.	List of Abbreviations	i
2.	List of Tables	ii-iii
3.	List of Figures	iv-v
4.	Abstract	vi-x
5.	Introduction	1-3
6.	Aims and Objectives	4
7.	Review of Literature	5-33
8.	Materials and Methods	34-37
9.	Results and Observations	38-44
10.	Discussion	45-54
11.	Summary and Conclusion	55-57
12 .	Tables	xi-xviii
13.	Figures	xix-xxxiii
14.	Bibliography	xxxiv-xlii

LIST OF ABBREVIATIONS

AFM –Atomic Force Microscope
mm-Millimeters
rpm-Rotations per minute
SPSS- Statistical Package for Social Sciences.
nm^2 – Nanometer square
3D- Three dimensional.
LED -Light Emitting Diode
ANOVA- Analysis of Variance .
SEM- Scanning Electron Microscopy

LIST OF TABLES

Table 1	Root mean square value(nm^2) of samples of groups
Table 2	Mean root mean square value (nm^2) of different groups
Table 3	Comparison of mean root mean square value (nm^2) of Group-I with other groups
Table 4	Comparison of mean root mean square value (nm^2) of Group-II with other groups
Table 5	Comparison of mean root mean square value (nm^2) of Group-III (a) with other groups
Table 6	Comparison of mean root mean square value (nm^2) of Group-III (b) with other groups
Table 7	Comparison of mean root mean square value (nm^2) of Group-IV (a) with other groups
Table 8	Comparison of mean root mean square value (nm^2) of Group-IV (b) with other groups
Table 9	Multiple comparison of mean root mean square value (nm^2) values between the groups
Table 10	Comparison of mean root mean square value (nm^2) of Group-III (a) with Group-III (b)

Table 11	Comparison of mean root mean square value (nm^2) of Group-IV (a) with Group-IV (b)
Table 12	Colour value(nm) of samples of groups before polishing.
Table 13	Colour value (nm) of samples of groups after polishing
Table 14	Mean color value (nm) before polishing of different groups
Table 15	Mean color value (nm) after polishing of different groups
Table 16	Comparison of mean color value (nm) before and after polishing within the groups

LIST OF FIGURES

Fig. 1	Composites used in the study(Tetric evo ceram and IPS Empress Direct).
Fig. 2	Polishing systems used for the Study (AstroPol and Astrobrush).
Fig. 3	Moulds made for packing composites . (Dimensions - thickness 0.006 inches ,10mm diameter and 6 mm height)
Fig. 4	The composites packed and light cured.(LED Light curing unit).
Fig. 5(a)	Composite polished with Astropol
Fig. 5(b)	Composite polished with Astrobrush
Fig. 6	Atomic Force Microscope analysis of samples
Fig. 7	Spectrophotometer analysis of samples
Fig.8	3D image of group I
Fig. 9	2D image of group I
Fig. 10	3D image of group II
Fig. 11	2D image of group II
Fig. 12	3D image of group III(a)
Fig. 13	2D image of group III(a)
Fig. 14	3D image of group III(b)
Fig. 15	2D image of group III(b)
Fig. 16	3D image of group IV(a)
Fig. 17	2D image of group IV(a)
Fig. 18	3D image of group IV(b)

Fig. 19	2D image of group IV(b)
Fig. 20	Mean root mean square value(nm^2) of different groups
Fig. 21	Comparison of mean root mean square value(nm^2)of Group-I with other groups
Fig. 22	Comparison of mean root mean square value(nm^2) of Group-II with other groups
Fig. 23	Comparison of mean root mean square value(nm^2) of Group-III (a) with other groups
Fig. 24	Comparison of mean root mean square value(nm^2) of Group-III (b) with other groups
Fig. 25	Comparison of mean root mean square value(nm^2) of Group-IV (a) with other groups
Fig. 26	Comparison of mean root mean square value(nm^2) of Group-IV (b) with other groups
Fig. 27	Comparison mean root mean square value(nm^2) of Group-III (a) with Group-III (b)
Fig. 28	Comparison mean root mean square value(nm^2) of Group-IV (a) with Group-IV (b)
Fig. 29	Mean color value(nm) before polishing of different groups
Fig. 30	Mean color value(nm) after polishing of different groups
Fig. 31	Comparison of mean color value(nm) before and after polishing within the groups.

ABSTRACT

Introduction

Use of synthetic resins in restorative dentistry has markedly increased in recent years due to increased demand of aesthetics. Fillers in composite restorations have multiple roles: to reduce polymerization shrinkage as well as the coefficient of thermal expansion and water sorption and solubility, to mechanically reinforce the material, to improve optical characteristics and aesthetics of the material, to enable better initial polishing and polish retention, and to reduce wear during the masticatory forces.

Nanofillers have been developed with the aim of combining the advantages of hybrid and microfilled composites in the same restorative material. Nanofillers are described as "the discrete particles which have all of three dimensions in the range of about 1–100nm. Finishing and polishing of composite restorative material is a common clinical practice with the aim to improve its longevity and esthetics . Surface roughness can be measured upto nanoscale by qualitative methods such as scanning electron microscopy or quantitative methods such as profilometry. In recent years, atomic force microscopy (AFM) has been largely used in dentistry to study characteristics of different materials which allows a 3D imaging at a nano metric resolution and does not need to neither work in vacuum nor any preparation of the specimen. This technique has emerged as the most reliable in the evaluation of surface roughness.

The colour stability of composites is an important factor from an esthetic point of view.The colour value can be measured using colorimeter and spectrophotometer.

This *in vitro* study was done to estimate the surface roughness using AFM and colour stability using spectrophotometer of two nano-hybrid composite resins - Tetric evo ceram and IPS Empress Direct after polishing with two different polishing systems- Astropol and Astrobrush.

Aims and Objectives

Aim - To compare the surface roughness and immediate colour stability of Tetric evo ceram and IPS Empress Direct after polishing with astropol and astrobrush.

Objectives : To assess the surface roughness of the nanocomposites polished with two different polishing systems using atomic force microscopy and their immediate colour stability using spectrophotometry.

Methodology

A total of sixty samples were prepared in the study . The commercially available composite materials used in this study were Tetric evo ceram and IPS Empress Direct .Orthodontic bands of thickness 0.006 inches were used to make cylindrical metallic moulds of the dimensions 10mm diameter and 6 mm height. The composite material was placed in increments of 2mm or less and packed into the cylindrical metallic mould using a teflon coated composite placement instrument .A transparent matrix strip was applied on top of each increment of

composite with a constant pressure to extrude excess material ,to flatten the surface and to reduce voids at the surface. Each increment of composite were light cured for 40 seconds using LED light curing unit. of intensity 400 milli watts/ cm^2 . Following complete curing of the composite ,the metallic moulds were separated using a scalpel to obtain cylindrical composites of the specified dimensions. Colour stability of the flat surfaces were evaluated before polishing using spectrophotometer. The specimens were randomly divided into six groups of ten specimens each . Groups used in the study were as follows : Group- I - Unpolished Tetric evo ceram ,Group -II - Unpolished IPS Empress Direct,Group-III(a) – Tetric evo ceram polished with astropol. Group –III(b) - Tetric evo ceram polished with astrobrush , Group –IV(a)- IPS Empress Direct polished with astropol, Group – IV(b)- IPS Empress Direct polished with astrobrush. Each of the flat surfaces of the samples were polished unidirectionally (four strokes each) for eight seconds each using the two different polishing systems, 1 .Astropol with its finishing grit, polishing grit and high gloss polishing grit respectively.2.Astrobrush at low speed using a micro motor hand piece. Immediate colour stability was evaluated after polishing using spectrophotometer. The cylindrical composite specimens were placed in normal saline before evaluating the flat surfaces for surface roughness using AFM. The data were statistically analyzed using one - way analysis of variance(ANOVA) ,Post hoc and Dunnett's test.

Results and Observations

The results showed that among the experimental groups the maximum root mean square value of 1.93±0.03 nm^2 was observed for group IV(a) [Tetric evo ceram polished with astropol] when compared to Groups-III(a), III(b), IV(b), ($P<0.05$), is considered statistically significant.

The minimum root mean square value of 0.22±0.02 nm^2 was observed for Group-IV(b) [IPS Empress Direct polished with Astrobrush] when compared to Groups - III (a), III (b), IV (a) , ($P<0.05$), is considered statistically significant.

The results showed that there is very minimal changes in colour values of groups before and after polishing with the two different polishing systems , ($P>0.05$), is considered statistically insignificant.

Conclusion

Superior polish was obtained when the composites were polished with astrobrush when compared to those polished with astropol. There was very minimal difference in the colour stability of the composites before and after polising using the two different polishing systems.

Clinical Significance

The esthetics and longevity of composite restorations strongly depends on the quality of the surface finishing and polishing as well as its colour stability . The presence of irregularities or change in its colour can influence appearance, plaque

retention, surface discoloration, gingival inflammation .In addition, the surface roughness of composites can reduce the hardness and increase the wear of these restorations, hence the importance of proper finishing and polishing as well as the colour stability of composite restorations.

INTRODUCTION

The demand for esthetics has been on the rise in recent years resulting in the use of more tooth coloured restorative materials.[1] Optically, the translucent materials usually are more esthetic than the layered and opaque materials.[2] Fillers in composite restorations have multiple roles: to reduce polymerization shrinkage, to reduce the coefficient of thermal expansion and water sorption and solubility, to mechanically reinforce the material, to improve optical characteristics and aesthetics of the material, to enable better initial polishing and polish retention, and to reduce wear during the masticatory forces.[3]

Initially the composites had properties that were inferior to amalgam. They were subsequently modified to improve their physical and mechanical properties. Based on their consistency, dental composite restorative materials are available as flowable and packable composites. The composites are also available as conventional composites, microhybrid composites and nanohybrid composites bases on their filler particle sizes.[4]

The emergence of a new breed of composite resins comprising very small-sized particle technology enables dentists to provide both strong and life-like aesthetic restorations. These new breeds of composite resins termed "nanofilled composites" promise better polish, longevity of luster, better handling and high strength. Nanofillers have been developed with the aim of combining the advantages of hybrid and microfilled composites in the same restorative material. Nanofillers are described as the discrete particles which have all of three dimensions in the range of about 1–100nm.[2] Application of

nanotechnology in composites with nanoparticles and nanoclusters have been introduced which reduces the interstitial spaces among the inorganic particles, providing better physical properties and polish maintenance, which can be seen in the surface texture.[5]

IPS Empress Direct is a light-curing, highly esthetic nano-hybrid composite filling material for direct restorative procedures in the anterior and posterior region.[6] Tetric evo ceram is the universal composite for anterior and posterior restorations that affords outstanding esthetics. The filler technology employed in Tetric evo ceram is based on an optimum blend of different fillers and filler sizes.[7]

Finishing and polishing of composite is a common clinical practice with the aim to improve their longevity and esthetics .[8] The presence of surface irregularities arising from poor finishing/polishing techniques and/or instruments can create staining, plaque retention, gingival irritation, recurrent caries, abrasivity, wear kinetics and tactile perception. A smooth surface adds to the patient's comfort as a change in surface roughness of 0.3 mm can be detected by the tip of the tongue.[9]

Astrobrush is a high-gloss polishing system that produces lustrous results without requiring the use of polishing paste as each bristle acts like a small polishing instrument.[10] Astropol has been especially designed for polishing composite materials but it can also be used for polishing amalgam. [11]

Surface roughness can be measured up to nanoscale by qualitative methods such as scanning electron microscopy or quantitative methods such as profilometry. In recent years, atomic force microscopy (AFM) has been largely used in dentistry to study characteristics of different materials which allows a 3D imaging at a nano metric resolution and does not need to work neither in vacuum nor any preparation of the specimen. This technique has emerged as the most reliable in the evaluation of surface roughness.[12] Reproducible colour measurements can only be achieved using standardized colour-quantifying methods such as spectrophotometry, colorimetry, and image analysis techniques. Computer analysis of photographic images has been used in several studies that evaluate colour changes, constituting an efficient method that provides objective, quantifiable, and reproducible results.[13]

This *invitro* study was done to evaluate the surface roughness by means of AFM and colour stability by means of spectrophotometry of two nano-hybrid composite resins- Tetric evo ceram and IPS Empress Direct after polishing procedures performed with two polishing systems- Astropol and Astrobrush .The study hypothesis was that the composites polished with astrobrush would show a superior surface finish when compared to the composites polished with astropol and that there would be no difference in the immediate colour stability before and after polishing with both the polishing systems.

AIMS & OBJECTIVES

Aim

To evaluate and compare the surface roughness and immediate colour stability of Tetric evo ceram and IPS Empress Direct after polishing with astropol and astrobrush.

Objectives

To assess the surface roughness of the nano composites polished with the two different polishing systems using atomic force microscopy and their immediate colour stability using spectrophotometry.

REVIEW OF LITERATURE

Filho *et al.* 2003[14] did a study on the surface roughness of composite resins after finishing and polishing. The study evaluated the effect of surface finishing methods on the average surface roughness of resin composites. Seven composites and two polishing systems were used.Filtek Z250 ,Solitaire, Alert, Suprafill, Fill Magic, Surefil, Definite were the composites used for the study .They were polished using diamond burs and aluminum oxide discs. The results showed no statistical difference in average surface roughness between the polyester strip and aluminum oxide discs ($P>0.05$). However, finishing with diamond burs showed a statistically higher average roughness for all composites ($P<0.05$). Statistical differences were detected among materials ($P<0.05$) in the use of diamond burs.

Gupta R *et al.* 2005[15] conducted an *in vitro* study ,in this particular study the veneering materials were subjected to coloured beverage commonly consumed and analysis was later done to know the colour value using spectrophotometry. The material used included composites which include Filtek 250Z and Tetric ceram and porcelain material vitadur alpha.The beverages included tea, coffee, coca-cola and distilled water as control.The results were later studied under reflectance spectrophotometer and CIELAB system.The results showed that the porcelain material were considered more colour stable when compared to the two composite material which were less colour stable .

Ahmed KI *et al.* 2005[16] did an *in vitro* spectrophotometric study on color stability of ionomer and resin composite restoratives in various environmental solutions. Three Ionomer based esthetic restorative materials were used which were Glass Ionomer, resin modified glass Ionomer, and compomers.The samples were aged in four different solutions (deionized water, 75% ethanol, 0.1 mole acetic acid solution & 10% hydrogen peroxide). The color changes were measured by a reflection spectrophotomer.They concluded that the light cured resin-modified Glass Ionomers and compomers showed high color change in 10% hydrogen peroxide solution. The light-cured composite showed insignificant color change in all the experimental solutions.

Watanabe T *et al.* 2005[17] conducted a study to find the influence of duration of polishing on the surface roughness of resin composites. The polishing systems used were Compomaster (Shofu), Silicone Points C Type (Shofu), Super Snap (Shofu) and Enhance Finishing and Polishing System (Dentsply/Caulk). The composite used in the study were Clearfil AP-X (Kuraray Medical) and Lite-Fil II A (Shofu). The average surface roughnesses was determined using a profilometer.Thus from the results they inferred that although the smoothest composite surface was obtained with the multi-step polishing systems, the one-step polishing point composed of diamond particle-impregnated rubber produced a clinically acceptable surface with relatively short polishing duration.

Krithika AC *et al*. 2006[18] conducted study on wear analysis of nano ceramic composites against a ceramic antagonist where the purpose is to measure the three body occlusal contact area wear of different restorative materials against a ceramic antagonist since ceramic restorations are common against composite restorations the composite materials in the study includes SR Adoro,Surefil,Filtek p60 and a nano ceramic composite Ceram X mono.The surface has been analysed by surface profilometer. Comparing the results among the direct composite materials analysed in this study, nano ceramic composite with the nano-sized fillers had significantly lower mean wear depth than the other two packable composites.

Lal SM *et al.* 2006 [2] did a study in which a new technique has been proposed for placement of composite in single visit using the modified customized matrix .From results they found that the restoration is predictable and easily achievable, the proposed technique provides direct bonding to the tooth material, smooth and finished surface easily achievable and It is both esthetic and economical.

Ergucu Z *et al*. 2007[19] did a study to evaluate the surface roughness of composite after polishing with one step polishing system . The resin composites evaluated in this study include CeramX, Filtek Supreme XT, Grandio, Premise and Tetric EvoCeram.The polishing system used were PoGo, OptraPol and One Gloss discs. Surface roughness tester was used for the anlysis of the samples .They proved that the polishing effect of PoGo was better than other polishing systems. Considering the reduced steps, application

time, elimination of cross-infection risks and , PoGo diamond micro-polisher can be used for polishing these novel materials. The question, to what degree a surface must be finished, cannot be answered sufficiently at the moment. Their results suggest that, in order to achieve long-lasting esthetics in resin composite restorations, special attention should be paid to obtaining optimal resin polymerization and a perfect surface finish by polishing.They suggested that additional studies are needed to determine which of the new finishing and polishing techniques is best suited to clinical situations where access is limited and restoration surfaces are concave.

Santhosh L *et al.* 2008[20] did a study on influence of different composite placement techniques on microleakage in preparations with high C-factor.The study evaluated the marginal leakage around class I cavity preparations using different composite placement techniques .They concluded that none of the techniques for resin placement was able to eliminate marginal microleakage in Class-I cavity preparation. There was no statistical difference among the three groups with different resin placement techniques in cavity with high C-factor. Moreover the control of marginal microleakage with a high C-factor presents a challenge, regardless of the resin composite insertion techniques.

Chicea B *et al.* 2010[21] conducted an AFM and SEM study of a dental restoration material grain structure.The composite used was Charisma Opal. The atomic force microscope technique was used to investigate the distribution of the smaller particles, with diameters below 70 nm, while the Stereo electron microscope was use to investigate the bigger particles, with diameters ranging

up to 1600 nm. They inferred that Charsima Opal is a hybrid combination of both micro and nanostructured material.

Bashetty K *et al.* 2010[9] conducted a study in which they compared the effect on one step polishing system and multi step polishing systems on the surface texture of composite restorative materials.The two composite materials under study are Esthet-X and Solitaire –II. The single step polishing system used in the study was PoGo and the multi step polishing system used was Super Snap polishing system.The surface roughness were then assessed using a profilometer.They found that mylar strip produdced the best finish . It was suggested that the effect of finishing and polishing systems on surface roughness was material dependent .They also held the fact that finish of mini hybrid composite was significantly better than packable composite.They suggested that with the reduced steps, application time and the elimination of cross-infection risks, one- step polishing systems may be preferred for polishing resin composites.

Endo T *et al.* 2010[22] conducted a study on surface texture and roughness of polished nano filled and nano hybrid resin composites.The nano filled resin used was Filtek Supreme XT and the nano hybrid resin used was Grandio, Tetric EvoCeram, Venus Diamond. The polishing systems used in this study are Venus Supra , Compo Master , DirectDia Paste , Sof-Lex Pop-On Discs In this study the samples were analysed using both scanning electron microscope and profilometer . They proved that the surface roughness achieved with the final polishing steps of the Venus Supra and SofLex systems on the

four nanofill and nanohybrid resin composite materials was very satisfactory and well below the clinically acceptable threshold value . As for the diamond polishing system comprising the Compo Master and DirectDia Paste, the study recommends only for nanofill Filtek Sumpreme XT and nanohybrid Tetric EvoCeram in light of the results obtained . For glass filler-loaded nanohybrid composites Grandio and Venus Diamond, higher surface roughness was obtained as well as detrimental surface alteration with varying degrees of glass filler dislodgement.

Oliveira AL *et al.* 2010[23] conducted a study to find the influence of finishing and polishing and immersion methods on the surface roughness and hardness of a composite resin . The composite used in the study was Filtek Supreme XT. The polishing systems used were Super-Snap disks.The immersion solutions included in the study were artificial saliva, sodium fluoride solution at 0.05% - manipulated, Fluordent Reach, Oral B, Fluorgard.The specimens were initially analysed for surface hardness using surface roughness tester and Vickers microhardness were measured.Thus from the results obtained they summarised that the surface roughness and microhardness of the Filtek Supreme XT were influenced by the finishing and polishing procedure, independently of the immersion methods.

Mopper KW 2011[24] in a review article on contouring, finishing, and polishing anterior composites explains why finishing and polishing is important in restorative procedures of composite restoration.He also mentions step by step procedure for composite restoration. The article also mentions in

classIII,IV,V composite restorations along with diastema closure. He also emphasizes on full resin bonded veneer . The aricle also gives insight to maintenance of composite restorations.

Atali PY *et al.* 2011[25] conducted a study on the effect of bleaching methods on the surface roughness and hardness of composite materials.The bleaching systems used were 38%HP Opalescence Xtra Boost and 35% HP Beyond Maxx and home bleaching systems which were Opalescence PF 35% and Beyond 6%. The composites used were Aelite, Grandio, Clearfil Majesty, Siloran. The samples were studied under 3D profilometer .They found that Siloranes show the highest surface roughness and lowest surface hardness after exposure to the bleaching agents. No significant difference was found between nano superfilled composite and nano hybrid composite for surface roughness and hardness. No significant difference was found between bleaching agents for surface roughness of the tested composites.

Bertoldo CES *et al.* 2011[3] did a study to evaluate the surface roughness and colour stability of composite resin after different polishing protocols.The composite materials used were Z250(3M ESPE, St. Paul, MN,USA)and 4 Seasons(Ivoclar Vivadent (Schaan, Liechtenstein)) .The polishing used in the study were Sof-Lex(3M/ESPE, St. Paul, MN,USA) and Jiffy (Ultradent Products INC ,UT,USA.)The surface roughness was analyzed using a surface roughness tester and the baseline colour values were observed by a spectrophotometer.They came to the conclusion that when any polishing procedure was realized, the resin composites presented greater surface

smoothness and lower staining they also stated the silicon polishing system presented lower roughness values and coffee staining.

Hosoya Y *et al.* 2011[12], conducted a study on the effects of polishing on the surface roughness and colour of resin composites.The composites used for the study were Estelite Σ Quick, Clearfil Majesty, and Beautifil II.The surface roughness was evaluated using laser scanning microscope and the baseline colour values were measured by spectrophotometer. They showed that the effect of polishing on surface roughness and gloss differed by resin composite and shade. Limited significant correlations between color parameters and both surface roughness and gloss were obtained, and correlations differed among the resin composites and by shade.

Loomans B *et al.* 2011[26] conducted a study their aim of this study was to investigate the effect of various etching protocols on the surface roughness of composites with different filler composition.The composites used were hybrid-filled Clearfil AP-X; nano-filled Filtek Supreme XT.The surface treatment was done by eight surface treatments Group 1. No surface treatment (NC),Group 2. Etching with 37% phosphoric acid (DMG) for 20 s ,Group 3. Etching with 3% hydrofluoric acid (Porcelock, Den- Mat) for 20 s ,Group 4. Etching with 3% hydrofluoric acid (Porcelock Den- Mat) for 120 s , Group 5. Etching with 9.6% hydrofluoric acid (Porcelain etch, Pulpdent) for 20 s , Group 6. Etching with 9.6% hydrofluoric acid (Porcelain etch, Pulpdent) for 120 s , Group 7. Etching with 37% phosphoric acid for 20 s followed by etching with 9.6% hydrofluoric acid for 120 s ,Group 8. Etching with 9.6% hydrofluoric

acid for 120 s followed by etching with 37% phosphoric acid for 20 s . The samples were analyzed by scanning electron microscope .They concluded that composite resins should not be seen as a group of materials having identical properties when it comes to repair. The effect of etching will depend on the composition of the filler particles.

Dutta S *et al.* 2012[1] did an *in vitro* profilometric study to find the effect of various polishing systems on the surface roughness of nano microhybrid composite restoratives.The composites used were Filtek Z250 and Supreme XT . The polishing systems used were Optra Pol and Sof Lex.They came to the conclusion that nano filled composites (Supreme XT) showed better polishing ability when compared with microhybrid composites (Filtex Z-250) whereas mylar strip provide the smoothest surface finish for both supreme XT and Filtek Z-250.

Gharechahi M *et al.* 2012[27],has done a review on the effect of surface roughness and material composition on biofilm formation . They were to evaluate the influence of the surface roughness and the restorative material composition on the adhesion process of oral bacteria.They found that rough surfaces will promote plaque formation and maturation. They further stated that biofilms on gold and amalgam are thick, but with low viability. The Glass-ionomer cement collects a thin biofilm with a low viability whereas biofilms on composites cause surface deterioration, which enhances biofilm formation. Biofilms on ceramics are thin and highly viable.Thus they deduced that the rougher surfaces which are crowns, dentures, and restorations accumulate and

retain more plaque. The structure and composition of biomaterials have also an important effect on microbial colonization.

Bansal K *et al.* 2012[28] did an *in vitro* study to check the effect of alcoholic and non alcoholic beverages on color stability and surface roughness of resin Composites. The composite materials used in the study were Methacrylate Based Nanofilled Composite {CERAM XTM Mono (Dentsply Caulk, DE, USA)}and Silorane Based Microhybrid Composite {FILTEKTM P90 (3 M ESPE St. Paul, MN, USA)}.The polishing system used were Super Snap polishing system. The beverages used were Whiskey, CocaCola, Nimbooz, and Distilled water.Each samples were analysed for surface roughness with a profilometer and baseline colour values using a spectrophotometer .They confirmed that silorane based resin composites were more stable in different beverages over time. They also stated that effect of interaction of different resin composites, various beverages, and time depended on a multitude of factors.

Nunes C *et al.* 2012[29] did a Spectroscopic *in vitro* study to evaluate the effects of health drinks on the color stability of anterior restorative materials.The composite used are Brilliant™ (Coltene Altstättan, Switzerland). The polishing systems included Sof-Lex™ (3M ESPE, India)and OptraPol®, (Ivovlar Vivadent AG., Schaan, Liechtenstein).The immersion media used were commercially available Red Bull, Gatorade, Cloud 9, and nonflavored fruit juices. The samples were polished and analyzes using a spectrophotometer. They concluded that commercially available health drinks

will affect the color stability and surface staining of composites, regardless whether polished with either diamond or aluminium oxide discs. Composite restorations are most susceptible to color degradation and staining if exposed to commercially available health drinks within 96 h of placement.

Tuncer D *et al.* 2013[30] did a study to check whether the temperature of beverages affect the surface roughness, hardness, and color stability of a composite resin. The composite used was Filtek Z250.The immersion agents consisted of Coffee at 70°C, coffee at 37°C, cola at 10°C, cola at 37°C,and artificial saliva. The baseline colour values were observed by spectrophotometer .Microhardness of samples were observed by Vickers surface microhardness device. From the study they deduced that High temperature solutions caused alterations in certain properties of composites, such as increased color change, although they did not affect the hardness or roughness of the composite resin material tested.

Sapra V *et al* . 2013[31] conducted a comparitive study to assess the surface geometry of different nanofilled composited after polishing with different polishing system.The composites used for the study are Filtek 350 xt,Ceram X Mono, and Tetric N-Ceram.The polishing systems used in this study were SpinBrite,CompoMaster,Astropol and Soflex. The Average roughness were analysed using a ten point perthometer.They drew to a conclusion that the surface roughness decrease with the increase in the number of polishing steps where one step and multi step polishing systems produced similar quality of surface finish for nano hybrid composites .

Lainović T *et al*. 2013[32] conducted an atomic force microscope study on surface texture and topography of nano composite restorative material after being polished by two different polishing protocols.The composites used in the study were Filtek Ultimate Body and Filtek Z550.The polishing systems used were OneGloss and Super Snap .The samples were analysed under the AFM.They concluded that multi-step polishing protocol produced significantly lower surface roughness values, for both tested materials when compared to one-step polishing protocol, even when it was followed by diamond paste polishing.

Fawad N 2013[33] conducted a study on the effect of different polishing procedures on color stability of nanocomposites in different mouth rinses.The composite used in the study was Filtek Z350 XT (3M).The polishing system used in the study was SofLex And PoGo.The mouth rinses used in the study were Listerine, Cool Mint,and Enziclore.The baseline colour values were measured with Spectrophotometer.The study concluded that in nanocomposites multistep polishing procedures with Sof-Lex discs promoted greater staining resistance than single-step polishing technique with PoGo polishers.The study also stated that Cool Mint Listerine (alcohol containing) and Enziclore (chlorhexidine-containing) mouth rinses showed the highest value of discoloration as compared to Listerine (non-alcohol containing mouth rinse) and artificial saliva. However, these differences were not visually perceptible.

Lainović T *et al*. 2013[34] conducted an atomic force microscope study on surface roughness and topography of nano composite restorative material after being polished by two different polishing protocols.The composites used in the study were Tetric evo Ceram and Filtek Z550.The polishing systems used were Super Snap .They samples were analyzed under the AFM.They it can be concluded that the type, size, distribution of fillers and filler loading of all of the tested materials, didn't affect average surface roughness of the samples after finishing and polishing procedure. On the other hand, different material compositions affected the topography of the polished surfaces of the materials.

Goyel P *et al.* 2013[35] conducted an *in vitro* study to compare erosive potential of different beverages on enamel and tooth colored restorative materials. The composites used were Filtek Z350 and GIC GC Fuji IX.The beverages used for the study were freshly prepared orange juice, apple juice, tomato soup and tap wateras control.The samples were analysed under a profilometer.They concluded that before immersion, Group II (Enamel) had the minimum surface roughness followed by Group III (Nanocomposite) and Group I (GC Fuji IX) respectively. After immersion the results showed that erosion of enamel was significantly higher than tooth-colored restorative materials. Erosive potential of orange juice was highest followed by tomato soup and apple juice. All the beverages used in the study caused erosion of enamel and tooth-colored restorative materials. Erosion caused by orange juice was higher followed by tomato soup and apple juice. Erosion of enamel was significantly higher than GIC and nanocomposite.

Zuryati A *et al.* 2013[36] did a study to find the effects of home bleaching on surface hardness and surface roughness of an experimental nanocomposite.The composites used in the study were nanocomposite (Filtek Z350), anterior nanocomposite (KeLFiL), and nanohybrid composite (TPH 3).The bleaching agent used were 10 and 20% Opalescence PF home bleaching agent.The samples were tested under atomic force microscope .They deduced that After 14 days of home bleaching treatment, there was no adverse effect on the surface roughness of all three composite resins, although the surface hardness for KeLFiL and TPH 3 were significantly reduced.

Pinto Gd *et al.* 2013[37] did a study to check the Influence of finishing and polishing on color stability and surface roughness of composites submitted to accelerated artificial aging .Two composites were used for the study.The polishing systems used were tip 3195 F, tip 3195 FF, tip 3195 F + diamond paste, tip 3195 FF + diamond paste ,and , Sof-Lex discs. The samples were measured by spectrophotometer and surface roughness meter.They derived to a conclusion that in spite of the surface differences, the different finishing and polishing procedures were not capable of providing color stability within the clinically acceptable limits.

Tornavoi DC *et al.* 2013[38] conducted a study on Color change of composite resins subjected to accelerated artificial aging . Three composite resins were evaluated of which two microhybrids and one hybrid of higher viscosity . Colour values were obtained by spectrophotometer before and after aging . From the study they concluded that all composite resins presented

unacceptable color changes after 382 h of aging and different composite resins with same hue, presented different colors before being subjected to the aging process .It was also observed color difference within a group of the same composite resin and same hue.

Uppal M *et al.* 2013[39] did a profilometric analysis of two composite resins surface repolished after tooth brush abrasion with three polishing systems .The composite materials used in the study were microfilled composite resin Durafill and microhybrid composite resin Charisma.The polishing system used are Enhance, One Gloss, and Sof-Lex polishing systems. After polishing the samples were analysed by an 3D optical profilometer .They inferred that significant difference ($P < 0.05$) in surface roughness was observed. In simulated brushing following initial polishing procedure significantly roughened the surface of restorative material ($P < 0.05$).

Mallya PL *et al.* 2013[40] did a Profilometric study to compare the effectiveness of various finishing and polishing techniques on different restorative glass ionomer cements. The restorative materials used in the study were conventional GIC (Ketac Molar [3M ESPE, St. Paul, USA]), a light cured GIC (VitreBond [3M ESPE, St. Paul, USA]) and a nanofilled light cured GIC (Ketac N100 [3M ESPE, St. Paul, USA]). The polishing system used were Sof–Lex Disks (3M ESPE, St. Paul, USA), diamond finishing points (Mani, Dia Burs, Japan), tungsten carbide finishing bur (SS White burs Inc., USA).The samples were studied under a profilometer .They deduced that Control specimens (mylar strip) showed least surface roughness values followed by

SofLex disc, carbide finishing burs and diamond finishing points with all types of glass ionomer cements used in the study. Among the GICs tested, Nano ionomer showed least surface roughness followed by resin modified GIC and conventional GIC. Mylar strip produced the smoothest surface on all the GICs tested. Nano Ionomer showed the best polish ability with least surface roughness values.

Singh K *et al.* 2014[41] did a review on colour stability of aesthetic restorative materials after exposure to commonly consumed beverages. They conveyed that Dental porcelain has color and optical properties that simulate natural teeth. Inspite of porcelain restorations being considered color stable, yet discoloration is one of the major factors for failure of esthetic restorations. They have stated that most of the ceramics what are seen are feldspathic and more or less have same composition and firing cycles but all have shown different amount of color change and surface roughness and this discrepancy may be accredited to the difference in percentage of basic individual composition.

Taskinsel E *et al*. 2014[42]conducted a study on the effect of beverages and polishing systems on the colour of different composite materials.The resin composite materials used for this study were Cavex Quadrant Universal-LC, and Clearfil-APX.The beverages used for the study are Buzzer and Powerade. The colour values were measured before and after immersion using a colorimeter.the results showed that significant differences were observed in the colour values before and after immersion of which Clearfil Apx immersed in

Powerade showed the maximum colour value change where as the control groups immersed in distilled water showed the least .

De Alencar M L *et al*. 2014[43] did a study on the effect of drinks on the colour stability and surface roughness of nano composite restoration material .The composites used were Filtek Z350 XT and Evolu- X.The immersion solutions included Distilled water, Acai juice, Grape juice and Red wine. The samples were then measured by a digital spectrophotometer and were analyzed for surface finish using a profilometer. The results showed that there were significant changes in colour of all samples in two weeks time.Hence they deduced that red wine produced the greatest color change in nanocomposites, followed by grape juice. Acai juice made the color unacceptable clinically only after 12 weeks. Repolishing reduced the color change in all groups.

Barakah HM *et al*. 2014[8] did a study on effect of polishing systems on stain susceptibility and surface roughness of composite material.The composite material being studied were Filtek Supreme XT Tetric Evo Ceram and filtek Z250.The polishing systems used were PoGo, Astropol, or Hi-Shine.The sourface roughness was recorded by a profilometer where as the baseline colour values were recorded by spectrophotometer. They found that staining and surface roughness depend mainly on material composition and on the polishing procedures. Polishing improves the staining resistance of composite resins. Nanocomposite resins did not exhibit better staining resistance or surface roughness when compared microhybrid composite resin.

Say EC *et al* . 2014[44] conducted a study which evaluates the surface roughness of and morphology of composites when polished with two step polishing systems.The composites used were Estelite Omega ,Estelite Σ Quick , Esthet.X HD , G-aenial and Clearfil Majesty Posterior,Charisma Diamond, Beautifil II .The polishing systems used were Enhance/PoGo , Venus Supra.The samples were evaluated using a profilometer.They deduced that the surface roughness of micro-hybrid and nanohybrid composites seems to be dependent on materials and polishing systems.They also stated that aluminum oxide/diamond-abrasive impregnated two-step polishing system created smoother surfaces than the diamond-abrasive Impregnated two-step polishing system on supranano spherical filled composites.

Han JM *et al*. 2014[45] conducted a study on abrasive wear and surface roughness of contemporary dental composite resin. The composite materials used for the study are FiltekTMP60, FiltekTMP90, Clearfil Majesty Esthetic, Filtek bulk fill . Flow-It ALC, Revolution formula 2, FiltekTM Z350XT, Filtek Supreme XT, FiltekTMZ250XT, Tetric®N-Ceram, Tetric N Ceram Bulk Fill, Tetric N Ceram Bulk Fill, VENUS®Diamond, PremisaTM Packable, Clearfil majesty Posterior, Ceram x mono, Spectrum TPH 3, Fulfil extra, Wave mv, Estelite α.The samples were studied under a Scanning Electron Microscope.They concluded that the abrasive wear resistance of contemporary dental composite resins is material dependent and cannot be deduced from its category, filler loading and composite matrix. They also

conveyed that abrasive wear resistance of some flowable composites is comparable to that of the universal/posterior composite resins.

Nuaimi HO *et al.* 2014[46] did a study to measure effect of aggressive beverage on the color stability of different nano-hybrid resin based composite.The composites used in the study were Filtek Z 350 XT [3M ESPE, St. Paul, MN, USA], Ceram X Duo [Densply Caulk, Milford, DE, USA], and Venus Diamond [Heraeus Kulzer, Germany).The immersion solution were that of coffee and tea .The samples were studied in Spectrophotometer. They inferred that staining solutions are significant factors that affect color stability of composite resins.

Dionysopoulos D *et al.* 2015[47] did a study to analyse the effect of temperature, curing time, and filler composition on surface microhardness of composite resins. Two composites used for the study were used; Filtek Z250 and Grandio. Three different temperatures (23, 37, and 55 ^{o} C) were used, utilizing a composite warmer. Vickers microhardness measurements were performed on all samples .From the results they concluded that temperature of composites affects their surface microhardness. Also, light-curing time influence microhardness values of the composites tested.

Uzun G *et al.* 2015[48] did a study to analyze the effect of curing time and immersion solutions on discoloration of hybrid composites and nanocomposites. The composites used for the study were Filtek Ultimate Universal Restorative, Grandio, Herculite Classic, Tetrik N-Collection,

Ceram.X, Spectrum TPH3.The immersion solution consisted of coffee, tea, Coke®, cherry juice and distilled water.The color measurements were performed with a digital spectrophotometer .They concluded that there was no significant difference in color change between two curing times, and coffee was the immersion medium that promoted the highest color change on the tested composite resin.

Polli MJ *et al.* 2015[13] conducted a study on Effect of finishing and polishing on the color stability of a composite resin immersed in staining solutions. The composites used for the study were Opallis.The polishing systems used were Diamond Pro Discs, 3195 F and FF Diamond burs, Diamond R Polishing Paste, Diamond Felt Polishing Disc, Enhance point, 100- grit SiC paper.The samples were studied unser a spectrophotometer for baseline colour values.They concluded that The finishing and polishing method, staining solution, and immersion time influences the color stability. Finishing and polishing should be applied to obtain a more stain- resistant surface.

Chour RG *et al.* 2015[49] conducted an *in vitro* study on Comparative evaluation of effect of different polishing systems on surface roughness of composite resin .The polishing systems used for the study were , sof-lex discs, diamond tips, and Astrobrush.Once polished the samples were studied using a profilometer .They concluded that composite surface roughness after polishing was statistically significant between the groups. Sof-lex group produced lesser

surface roughness compared to control, Astrobrush, and diamond group. They also stated that diamond tips can be used to remove rough surface whereas sof-lex can be used for final finish and polish of the composite restoration.

de Oliveira Lima M *et al.* 2015[50] did an *in vitro* study on the effect of different polishing techniques on the surface roughness of composite resins submitted to at-home and in-office bleaching procedures.The composites used for the study were microhybrid and nanofilled in nature.Two different systems were used were Jiffy and SofLex.After the polishing procedure the samples were analysed by using a profilometer.They concluded that the polishing is an important procedure to reduce the roughness of dental restorations and composite surface polished with jiffy system improved the degradation resistance to the bleaching agents compared to SofLex discs.

Pantić M *et al.* 2015[51] conducted a study with the aim of this study was to present AFM analysis of surface roughness of lithium disilicate glass ceramic (IPS e.max CAD) under different finishing procedure (techniques): polishing, glazing and grinding. The samples were analysed under the atomic force microscope .They concluded that surface roughness mostly depends on the finishing procedure (techniques). In order to avoid numerous negative effects, that are consequence of the high surface roughness, it should be strived to a finer finishing surface technique of ceramic restorations.

Hassan AM *et al.* 2015[52], did a study to analyse the effect of polishing systems on surface roughness of flowable, microhybrid, and packable resin composites. Three types of resin composites used in the study are Heliomolar flow, TPH spectrum, and Tetric Ceram HB .The three polishing systems used in the study are Astropol, Enhance, and Soflex . After polishing samples , the mean surface roughness value was measured using a surface profilometer.They concluded from the results that control group of each material recorded the lowest surface roughness value. Among the tested polishing systems, the groups finished with Soflex system exhibited the lowest surface roughness value value. Among the resin composites, Heliomolar flow exhibited the lowest surface roughness value, regardless of the polishing system used the smoothest surface of all types of resin composite was achieved under Mylar strip.

Rao DC *et al.* 2015[53] did a study in which he compared the surface roughness of three heat cured acrylic denture base resins with different conventional lathe polishing techniques. Three different commercially available heat-cured acrylic resin materials namely DPI, Meliodent and Trevalon Hi were selected.The polishing systems used were Universal polishing paste (Ivoclar) , Polishing cake (Bego),Pumice (Micro white, Asian chemicals),Gold Rouge (Bego). After polishing the materials were analyzed with scanning electron microscope.They deduced that among the polishing methods used, superior results were obtained with universal polishing paste

followed by polishing cake, Pumice and Gold rouge. Although Pumice and Gold rouge values produced greater roughness value, they were well within the threshold.

Sampath.S 2015[4] conducted a retrospective case control analytical study . The study evaluated the survival probabilities of three restorative parameters which were intactness,color value and marginal integrity. The study inferred that overall, the lower survival of marginal integrity may necessitate sooner replacements for restorations done using flowable universal combinations.

Halacoglu DM *et al.* 2016[54] conducted a study on Effects of staining and bleaching on a nanohybrid composite with or without surface sealant.The composite used in the study were A1 Shade, Z550 Filtek 3M ESPE, St.Paul, MN, USA.The three different staining solutions were ice tea, red wine, and cola.The bleaching agent used was 35% hydrogen peroxide gel.They concluded that staining and bleaching did not change the surface roughness of the groups . Discoloration in the red wine group was higher than for the other staining solutions. They also stated that application of liquid did not enhance the color stability and surface roughness of the composite resin restoration.

Miotti LL *et al*. 2016[55] did a study on colour stability of a composite based on immersion methods and surface treatments. The composites used in the study were filtek Z250 (microhybrid) and BisCover LV .The polishing system used in the study was Sof- Lex™ XT Pop (3M ESPE, St. Paul, MN, USA).Coffee was used as the major staining agent .The baseline color values

were analyzed by spectrophotometer .They concluded that All specimens submitted to partial immersion showed significantly lower color change values when immersed in coffee and the surface sealant group had the lowest value (<3.3), which is clinically acceptable. Therefore, surface sealant might be used in aesthetic restorations as an adjunct treatment to protected resin composites from external discoloration.

Karadas M *et al.* 2016[56] did a study to evaluate effects of hydrogen peroxide-based mouthwashes on color changes of stained direct composite resins.Their aim was to study the effect of three mouthwashes on color changes of three composite resins stained with tea.They used three composite resins namely Clearfil Majesty Esthetic , Filtek Z250 , and Charisma.The staining solution used was tea.The mouth wash used was Crest 3D White mouthwash, Listerine whitening mouthwash,Scope White SC mouthwash ,and Opalescence PF gel. the baseline colourvalues were measured using a spectrophotometer.They came to the conclusion that the discoloration of the specimens after immersion in the mouthwashes decreased significantly over time. Only the staining of the Clearfil Majesty Esthetic specimens treated with Crest 3D White mouthwash, Listerine whitening mouthwash, and Opalescence PF gel decreased to a clinically acceptable level at the end treatment period.

ALShetili MM *et al.* 2016[57] did a study regarding the Color stability of nano-filled, micro-hybrid, and silorane-based dental composite resin materials.The composite material used were Filtek Z350, Filtek P90, and Filtek Z250.The staining agents used were distilled water, red grape juice, green tea,

coffee. The samples were then studied under spectrophotometer for colour values. They concluded that silorane-based composites are more resistant to discoloration than bis-GMA-based composites and coffee had the highest effect on composite discoloration compared to other media.

Bohner LO *et al.* 2016[58] evaluated surface of restorative materials after immersion in mouthwashes. The restorative materials used were Filtek Z350, 3M ESPE and IPS e.max ceram,Ivoclar.The mouth rinses used were Periogard, and Colgate Plax.The surface analysis of samples were done using the aid of a Rugosimeter.They concluded that mouthwashes did not promote a significant change in surface roughness of composite resin. They also stated that cetylpyridinium chloride promoted an increase in surface roughness of dental ceramic.

da Rosa GM *et al.* 2016[59] evaluated effect of whitening dentifrices on the surface roughness of a nanohybrid composite resin.The restorative material used was Filtek Z350 XT (3M/ESPE). And the dentifrices used were Colgate Total 12 Professional Clean , Sensodyne Extra Whitener Extra Fresh , and Colgate Luminous White . The roughness of each group was analysed by the Surface Roughness Tester. They concluded that no hazardous effect on the roughness of nanohybrid composite resin can be expected when whitening dentifrices are used for a short period.

Baltacıoğlu *et al.* 2016[60] conducted a study on comparison of one-step and multistep polishing systems for the surface roughness of resin composites. This study analysed the effect of different finishing and polishing systems on

the surface roughness of a microfilled and a nanofilled resin composites.They used a Scanning electron microscope (SEM) and profilometer for the analysis of the surface roughness.The composites used were Amaris, and Clearfil Majesty Esthetic.The polishing systems used for the study are tungsten carbide burs, diamond burs, one-step diamond micropolisher from pogo, multi-step discs from super-snap. The results showed that nanofilled resin composite showed significantly lower surface roughness values than microfilled resin composites.They also concluded that regardless of finishing methods, diamond micro-polisher produced smoother surfaces than polishing discs.

Alkurdi RM *et al*. 2016[61] conducted a clinical evaluation of class II composite: Resin restorations placed by two different bulk-fill techniques. The composites used were Tetric Evo Ceram (Ivoclar Vivadent) ,Tertic N Ceram Bulk Fill (Ivoclar Vivadent), Sonic Fill (Kerr,Kavo).They came to the conclusion that both the bulk-fill techniques performed satisfactorily over the 12-month observation period. Due to the low viscosity of Sonic Fill, it may preponderance Tertic N Ceram Bulk Fill in the regard to depth of cure and marginal integrity and marginal discoloration.

Adusumilli H *et al*. 2016[62] conducted a study on color stability of esthetic restorative materials used in pediatric dentistry: An in *vitro* study.Their aim was to To evaluate the color stability of two tooth colored restorative materials (conventional glass ionomer cement and giomer) when immersed in various consumable drinks and food at different immersion periods .They concluded that Giomer showed more resistance to color change than

conventional GIC with all the tested media and immersion regimes.

Baig AR *et al.* 2016[63] conducted an *in vitro* study in which he composite material used in the study was Tetric N Ceram from Ivoclar Vivadent .The staining agents used includes mouth rinses namely Listerine, Eludril, Phosflur, Amflor, and Rexidin.The color values were recorded using color spectrophotometer .The results were then analysed and they showed that significant reduction in the mean color value (before and after immersion) was observed in nonalcohol containing mouth rinses .Hence they concluded that there was color shift in the nanofilled resin composite restorative material, but the color shift was dependent on the material and the mouth rinses used.

Kumari CM *et al.* 2016[64] did an atomic force microscopic study on evaluating the surface roughness of restorative composites after polishing .The composites used for the study were Surefil SDR (Dentsply), Clearfil Majesty posterior (KurarayEurope), Ever X(GC Corporation, Japan), TetricEvo Ceram(Ivoclar, vivadent), E-Filtek Z350 (3MESPE). The polishing system used were Super Snap Rainbow (Shofu, Inc., Kyoto, Japan).The samples were analysed using an atomic force microscope. They concluded that Tetric evo ceram and Filtek Z350 showed better surface finish when compared to the other composites being compared.

Patel B *et al.* 2016[65] conducted a study to determine the effect of polishing systems on the surface finish of nano hybrid composite restorations.The composites used in this study were Filtek Z350 and Tetric N Ceram.The polishing systems used were PoGo,OneGloss and Sof-Lex

spiral.The surface finish was analyzed using surface profilometer .They deduced that Tetric N ceram had better polishing property when compared to Filtek Z350 and that PoGo was the better polishing system when compared to the other polishing systems used .

Abzal MS *et al.* 2016[5] has conducted a study to evaluate the surface roughness of three different composites with three different polishing systems.The composite materials used in the study were Filtek Z350XT (Nano hybrid), T-Econom plus (Microhybrid), G-aenial Flo (Flowable).The polishing systems used were Astrobrush, Astropol, Soflex spiral wheel.After polishing the samples were measured with a profilometer .They concluded that the samples polished with soflex spiral wheel showed better surface finish , they also stated that G-aenial Flo exhibited least surface roughness value due to its reduced filler size and its uniform distribution.

Sabatini C *et al.* 2016[66] did a study to evaluate the colour change of ten commercially available resin composite systems immediately after polymerization, at 24 hours, and at 1 month of water storage. The composites used for the study were Tetric evo ceram, Ceram X ,Duo, Filtek Supreme Plus, Four Seasons, Point 4, Premise, Venus, Gradia Direct, Vit-l-Escence, Artiste. Colour measurements were recorded with a colorimeter.They concluded that colour change was evidenced for all brands, shades, and thickness.The greatest colour change was observed immediately after initial polymerization. Colour

change after 24 hours and 1 month were significantly less than those observed after polymerization.

MATERIALS & METHODS

MATERIALS USED IN THE STUDY:

a)Tetric evo ceram –Ivoclar/Vivadent,New York,USA

b)IPS Empress Direct - Ivoclar/Vivadent,New York,USA

c)Saline-Nirlife,Nirma Ltd,Gujarat,India.

d)Matrix strip-Samit products,New Delhi,India.

e)Orthodontic band- Samit products,New Delhi,India.

EQUIPMENTS/INSTRUMENTS USED IN THE STUDY:

a)Astropol- Ivoclar/Vivadent,Liechtenstein,Germany

b)Astrobrush- Ivoclar/Vivadent, Liechtenstein ,Germany

c)Composite placement instrument (Teflon coated)-
Dispodent,Chennai,India

d)Micromotor contra angled hand piece-NSK,Tochigi,Japan

e)Spectrophotometer -Systronics ,Mumbai India.

f)Atomic Force Microscope-Parks systems, Suwon,Korea.

g)LED Light curing Unit – Woodpecker,Guangxi,China.

h) Super welder/Solder - MS Dental Surgicals, Chennai , India.

Methodology

Preparation of samples

A total of sixty samples were prepared . The commercially available composite materials used in this study are as follows: Tetric evo ceram (Ivoclar/Vivadent,New York,USA) and IPS Empress Direct (Ivoclar/Vivadent,New York,USA). Orthodontic bands (Samit products,New Delhi,India.)of thickness 0.006 inches were used to make cylindrical metallic moulds of the dimensions 10mm diameter and 6 mm height by spot welding it using Super welder/Solder (MS Dental Surgicals, Chennai , India.) . The cylindrical metallic mould was placed vertically on a flat glass surface. Then the composite material was placed in increments of 2mm or less into the cylindrical metallic mould using a teflon coated composite placement instrument(Dispodent, Chennai,India).A transparent matrix strip(Samit products,New Delhi,India.) was applied on top of each increment of composite with a constant pressure to extrude excess material ,to flatten the surface and to reduce voids at the surface.

Each increment of composite were light cured for 40 seconds using LED light curing unit (Woodpecker,Guangxi,China) of intensity 400 milli watts/ cm^2 . Following complete curing of the composite ,the metallic moulds were separated using a scalpel to obtain cylindrical composites of the specified dimensions. Colour stability of the flat surfaces were evaluated

before polishing using spectrophotometer.(Systronics,Mumbai,India). The specimens were randomly divided into six groups of ten specimens each .

Groups used in the study:

Control Groups

Group- I - Unpolished Tetric evo ceram

Group -II - Unpolished IPS Empress Direct

Experimental Groups

Group- III(a) – Tetric evo ceram polished with astropol.

Group –III(b) - Tetric evo ceram polished with astrobrush.

Group –IV(a)- IPS Empress Direct polished with astropol.

Group –IV(b)- IPS Empress Direct polished with astrobrush.

Polishing of the samples

Each of the flat surfaces of the samples were polished unidirectionally(four strokes each) for eight seconds each using the two different polishing systems,

1. Astropol (Ivoclar/Vivadent,Liechtenstein,Germany)(10000 rpm) with its finishing grit, polishing grit and high gloss polishing grit .

2. Astrobrush (Ivoclar/Vivadent, Liechtenstein ,Germany) at low speed (3000-6000 rpm)using a micromotor contra angled hand piece(NSK,Tochigi,Japan).

Immediate colour stability was evaluated after polishing using spectrophotometer. The cylindrical composite specimens were placed in normal saline(Nirlife,Nirma Ltd,Gujarat,India) before evaluating the flat surfaces for surface roughness using Atomic Force Microscope(Parks systems, Suwon,Korea).

Statistical method of analysis:

The values obtained were tabulated and statistically analysed using computer software Statistical Package for Social Sciences(SPSS) (version 16.0) (SPSS Inc.,Chicago,IL,USA). The data were expressed with the mean and standard deviation . Unpaired sample 't' test was applied to find the statistical significance between the groups. One-way analysis of variance (ANOVA) followed by Post *hoc* and Dunnett's test was applied for multiple comparisons .P value less than 0.05($P < 0.05$) was considered to be statistically significant at 95% confidence interval.

RESULTS & OBSERVATIONS

Results

Table 1 shows the root mean square value(nm^2) which is the surface roughness of samples of each group.Group-I shows the root mean square values of unpolished Tetric evo ceram. Group-II shows the root mean square values of unpolished IPS Empress Direct .Group-III(a) shows the root mean square values of Tetric evo ceram polished with astropol. Group-III(b) shows the root mean square values of Tetric evo ceram polished with astrobrush. Group-IV(a) shows the root mean square values of IPS Empress Direct polished with astropol. Group-IV(b) shows the root mean square values of IPS Empress Direct polished with astrobrush.

Table 2 shows mean of root mean square value(nm^2) of different groups with mean and standard deviation. The results were as follows: Group-I - 2.76±0.03nm^2, Group-II - 4.55±0.29 nm^2, Group III(a)- 0.92±0.05 nm^2, Group-III(b)- 0.25±0.02 nm^2, Group- IV(a) - 1.93±0.03 nm^2, Group-IV (b)- 0.22±0.02 nm^2.

Table 3 shows comparison of mean of root mean square value (nm^2) of Group-I with mean and standard deviation with other groups ie., the unpolished Tetric evo ceram compared with other groups.

Table 4 shows comparison of mean root mean square value (nm^2) of Group-II with mean and standard deviation with other groups ie., the unpolished IPS Empress Direct compared with other groups.

Table 5 shows comparison of mean root mean square value (nm^2) of Group-III (a) with mean and standard deviation with other groups ie., Tetric evo ceram polished with astropol compared with other groups.

Table 6 shows comparison of mean root mean square value (nm^2) of Group-III (b) with mean and standard deviation with other groups **ie**., Tetric evo ceram polished with astrobrush compared with other groups.

Table 7 shows comparison of mean root mean square value (nm^2) of Group-IV (a) with mean and standard deviation with other groups ie., IPS Empress Direct polished with astropol compared with other groups.

Table 8 shows comparison of mean root mean square value (nm^2) of Group-IV (b) with mean and standard deviation with other groups ie., IPS Empress Direct polished with astrobrush compared with other groups.

Table 9 shows multiple comparison of mean of root mean square value (nm^2) with mean and standard deviation between the groups.

Table-10 shows comparison of mean of root mean square value (nm^2) with mean and standard deviation of Group-III (a) with that of Group-III (b).

Table-11 shows comparison of mean of root mean square value (nm^2) with mean and standard deviation of Group-IV (a) with that of Group-IV (b).

Table 12 shows colour value (nm) of samples of groups before polishing of each group.Group-I shows the colour value of unpolished Tetric evo ceram. Group-II shows the colour value of unpolished IPS Empress Direct .Group-III(a) shows the colour value of Tetric evo ceram before polishing with astropol. Group-III(b) shows the colour value of Tetric evo ceram before polishing with astrobrush. Group-IV(a) shows the colour value of IPS Empress Direct before polishing with astropol. . Group-IV(b) shows the colour value of IPS Empress Direct before polishing with astrobrush.

Table 13 shows colour value (nm) of samples of groups after polishing of each group. Group-I shows the colour value of unpolished Tetric evo ceram. Group-II shows the colour value of unpolished IPS Empress Direct .Group-III(a) shows the colour value of Tetric evo ceram after polishing with astropol. Group-III (b) shows the colour value of Tetric evo ceram after polishing with astrobrush. Group-IV (a) shows the colour value of IPS Empress Direct after polishing with astropol. . Group-IV (b) shows the colour value of IPS Empress Direct after polishing with astrobrush.

Table-14 shows mean colour values (nm) before polishing of different groups with mean and standard deviation. . The results for Group-I was 3.76±0.33, Group-II - 4.88±0.03, Group III(a) - 5.92±0.03 , Group-III (b) - 4.96±0.02, Group- IV (a) - 5.31±0.01, Group-IV(b) - is 3.97±0.01.

Table-15 shows mean colour value (nm) after polishing of different groups with mean and standard deviation. The results for Group-I was 3.77±0.33,

Group-II - 4.88±0.03 , Group III(a) - 5.92±0.01 , Group-III (b)- 4.96±0.04, Group- IV (a) - 5.31±0.04, Group-IV (b) - 3.97±0.01.

Table-16 shows comparison of mean colour value (nm) before and after polishing within the groups with mean and standard deviation.

Observations

Surface roughness (nm^2) in control groups:

Group-I and Group-II were the control groups .Group-I was unpolished Tetric evo ceram. Group -II consisted of unpolished IPS Empress Direct. Group II showed the maximum surface roughness which was 4.55±0.29 nm^2. Group-I showed lesser surface roughness which was 2.76±0.03 nm^2, ($P<0.05$), is considered statistically significant.

Surface roughness (nm^2) in experimental groups : .

The Groups-III (a), III (b), IV (a), IV (b) were the experimental groups. Group- III (a) in which Tetric evo ceram was polished with astropol. Group– III (b) in which Tetric evo ceram was polished with astrobrush. Group –IV (a) in which IPS Empress Direct was polished with astropol. Group – IV (b) in which IPS Empress Direct was polished with astrobrush. The maximum root mean square value was observed for group IV(a) which was 1.93±0.03 nm^2 when compared to groups Group-III(a), Group-III(b), Group-IV(b), ($P<0.05$), is considered statistically significant.

The minimum root mean square value was observed for Group-IV(b)which was 0.22±0.02 nm^2 when compared to Groups - III (a), III (b), IV (a) ,($P<0.05$), is considered statistically significant.

The maximum and minimum root mean square values among all groups:

The results shows that the maximum root mean square value was exhibited by Group -II which was 4.55±0.29nm^2 and consisted of unpolished IPS Empress Direct, ($P<0.05$), is considered statistically significant.

The minimum root mean square value was exhibited by Group-IV(b)which was 0.22±0.02nm^2 in which IPS Empress Direct was polished with astrobrush , ($P<0.05$), is considered statistically significant.

Multiple comparison of mean root mean square value (nm^2) between the groups:

Maximum mean root square value was observed in Group-II,statistically significant compared to other Groups($P<0.05$).Minimum root mean square value was observed in Group IV(b) ,statistically significant compared to Groups I,II,III(a),IV(a)($P<0.05$),not with Group III(b)($P>0.05$).Root mean square value of Group I was statistically significant when compared to other groups($P<0.05$). Root mean square value of Group III(a) was statistically significant when compared to other groups($P<0.05$). Root mean square value of Group III(b) was statistically significant when compared to Groups

I,II,III(a),IV(a)($P<0.05$),not with Group IV(b) ($P>0.05$). Root mean square value of Group IV (a) was statistically significant when compared to other groups($P<0.05$).

Comparison of mean root mean square value (nm^2) of Group-III (a) with Group-III (b):

The results shows comparison of mean of root mean square value (nm^2)with mean and standard deviation of Group-III (a) with that of Group-III (b) .Group III(b) has lesser root mean square value(nm^2)when compared to Group III(a).

Comparison of mean root mean square value (nm^2) of Group-IV (a) with Group-IV (b):

The results shows comparison of mean of root mean square value(nm^2) with mean and standard deviation of Group-IV (a) with that of Group-IV (b) .Group IV(b) has lesser root mean square value (nm^2) when compared to Group IV(a).

The colour value (nm) of Groups before and after polishing :

The results shows that the colour value(nm) of groups before polishing with polishing systems are as follows: Group-I(Unpolished Tetric evo ceram) was 3.76±0.33nm,Group-II(Unpolished IPS Empress Direct) was 4.88±0.03nm, Group-III-(a) (Tetric evo ceram before polishing with astropol) was 5.92±0.03nm ,Group-III(b)(Tetric evo ceram before polishing with

astrobrush) was 4.96±0.02nm,Group IV(a) (IPS Empress Direct before polishing with astropol) was 5.31±0.01nm,Group-IV(b) (IPS Empress Direct before polishing with astrobrush) was 3.97±0.01nm .

The results shows that the colour value of groups after polishing with polishing systems are as follows:Group-I(Unpolished Tetric evo ceram) was 3.77±0.33nm,Group-II(Unpolished IPS Empress Direct) was 4.88±0.03nm, Group-III(a) (Tetric evo ceram polished with astropol) was 5.92±0.01nm,Group-III(b) (Tetric evo ceram polished with astrobrush) was 4.96±0.04nm,Group-IV(a) (IPS Empress Direct polished with astropol) was 5.31±0.04nm,Group-IV(b) (IPS Empress Direct polished with astrobrush) was 3.97±0.01nm. The results showed that there was very minimal changes in colour values of groups before and after polishing with the two different polishing systems, ($P>0.05$), is considered statistically insignificant.

DISCUSSION

The composites polished with astrobrush showed a superior surface finish when compared to the composites polished with astropol and that there very minimal difference in the immediate colour stability before and after polishing with both the polishing systems. Thus the study hypothesis was accepted.

There has been a sharp increase in the use of composite restorative materials in modern day dentistry because of their esthetic property and versatility. The composite materials are available as flowable and packable types based on their consistency .They are also available as bulkfill and conventional based on their curing. Based on their particle size they are available as conventional, microhybrid and nanohybrid composite material.[4] The nanocomposites possess better physical properties and esthetics which increases the longevity of the restoration.[5]

Finishing and polishing of the tooth coloured restorations are the two steps which are generally considered important for their esthetics and the longevity. These procedures are necessary to properly reconstruct dental crowns and restore its morphologic and anatomic form as well as function .[64] A positive correlation was found between surface roughness and the amount of plaque accumulation .The factors that mediate plaque accumulation are 1) surface roughness; 2) marginal fit; and 3) contour. Polishing of the composite materials ensures the oral health and longevity of restorations. A smooth surface reduces the likelihood of adhesion, which means plaque is less likely to

accumulate on a polished surface. This leads to healthier, longer-lasting restorations. A smooth tooth surface minimizes gingival irritation and surface discoloration. A polished tooth is more biologically compatible with the gingival tissue, so the health of the gingival tissue is maintained. Proper contouring, finishing, and polishing will improve the marginal integrity of the restoration. Interproximal surfaces have the maximum potential for plaque retention, and polishing these surfaces will significantly lower patient's risk for secondary caries and periodontal disease. A highly polished tooth surface increases the reflective and refractive index of the restoration to create more natural and esthetic smiles. From a visual standpoint, a restoration simply cannot be left unpolished. If proper technique is followed, finishing and polishing greatly enhance the longevity, durability, and long-term wear resistance of the restoration. Finishing and polishing enhances patient comfort and satisfaction, and patients greatly appreciate the natural beauty and health benefits realized from a properly polished restoration.[24]

Tetric evo ceram is a nano-hybrid composite . It is light-curing type of composite which is radiopaque by nature .It is used for the direct restorative therapy. Tetric evo Ceram cures with light within wavelength of a range of 400–500 nm (blue light).The composition of Tetric evo ceram consists of monomer matrix which is composed of dimethacrylates which are 17–18% by weight. Fillers of Tetric evo ceram contains barium glass, ytterbium trifluoride, mixed oxide and prepolymer which are 82–83% by weight. A few certain additional contents includes additives, stabilizers and pigments which

are less than 1.0% by weight. The total content of inorganic fillers for the bleach shades are 79–80% by weight or 60–61% by volume, for all the other shades are 75–76% by weight or 53–55% by volume. The particle size of the inorganic fillers is between 40 nm and 3,000 nm with a mean particle size of 550 nm.[7]

IPS Empress Direct is an esthetic restorative material which imitate the optical properties of natural teeth which are dentin, enamel and characterization materials whose shades and levels of translucency are coordinated with each other.The composition of IPS Empress Direct include barium glass filler, mixed oxide, Ba-Al-fluorosilicate glass, Ba-Al-fluorosilicate glass, Ytterbium trifluoride, prepolymer, highly dispersed silicon dioxide, catalysts and stabilizers and pigments.Its physical properties include high flexural strength, low water absorption ,low water solubility , better radiopacity ,increased depth of cure and optimum translucency. The monomers determine the reactivity, strength, shrinkage and handling properties of the composite . Fillers of different chemical compositions and sizes are embedded in the monomer matrix . These fillers influence the wear resistance, strength, polishability, shine, radiopacity and translucency of the material. Coarse barium fillers are used in the dentin pastes to increase their strength. The enamel shade contains fine barium glass fillers , which impart favourable polishing properties, high surface lustre and low susceptibility to wear. Prepolymers are used to increase the strength of the dentin materials and reduce volume shrinkage. Spherical mixed oxide enhances the shine of the material

and smoothness. Ytterbium trifluoride is added to heighten radiopacity and provide fluoride releasing properties.[6]

Astropol is a polishing system that provides polishing results in three steps. Astropol has been designed for polishing composite materials but it can also be used for polishing amalgam. They are available in four different shapes and allow a maximum of flexibility to ensure that all restoration areas can be conveniently accessed for lustrous results.The three polishing steps include Step 1: Pre-polishing, Step 2: Polishing and Step 3: High gloss polishing.[11]
Astrobrush is a composite polishing system which is used in a single step .They do not require a polishing medium. The brushes provide a lustrous shine to pre-polished composite restorations. Three different shapes available of Astrobrush provide easy access to all areas of a tooth structure. They incorporate a smart working mechanism in which the abrasive medium silicon carbide is integrated into the special fibres of the polishers. As the bristles wear down, fresh abrasive medium is released on the surface for better polish.[10]

Orthodontic bands of thickness 0.006 inches were used to obtain standardised cylindrical metallic moulds of the dimensions 10mm diameter and 6 mm height each . The composite was placed in increments of 2mm or less and light cured for 40 secs each to ensure complete polymerization. Each of the flat surfaces of the samples were polished unidirectionally(four strokes each) for eight seconds each to standardize the polishing procedure.

Qualitative methods such as scanning electron microscopy are used to measure surface roughness upto nanoscale . Quantitative methods to measure

surface roughness include profilometry . In recent years, atomic force microscopy (AFM) has been largely used in dentistry to study characteristics of different materials. AFM allows a three-dimensional (3D) imaging at a nanometric resolution and does not need neither to work in a vacuum nor any preparation of the specimen. This technique has emerged as the most reliable in the evaluation of surface roughness.[64]

The colour of the restoration is an important factor in aesthetics of the material. Recent times have seen the emergence of many nano composite materials which have better resistance to colour changes. Colour sustainability of restorative materials is necessary to assess the success or failure of the treatment. This is done using a Spectrophotometer which measures the value of colour.[62]

The results showed that among the control groups , Group II showed the maximum surface roughness which was 4.55±0.29 nm^2 whereas Group-I showed lesser surface roughness which was 2.76±0.03 nm^2, ($P<0.05$), is considered statistically significant.

Among the experimental groups , the maximum root mean square values was observed for group IV(a) which was 1.93±0.03 nm^2 when compared to groups Group-III(a), Group-III(b), Group-IV(b), ($P<0.05$), is considered statistically significant. This may be because of the fact that the tungsten carbide incorporated in Astropol was inferior in removing the surface irregularities of resin composites when compared to silicon carbide incorporated in Astrobrush.[5]

The minimum root mean square values was observed for Group-IV(b)which was 0.22±0.02 nm^2 when compared to Groups - III (a), III (b), IV (a) ,($P<0.05$), is considered statistically significant. This may be due to the fact that the enamel shade of IPS Empress Direct contains fine barium glass fillers , which impart favourable polishing properties, high surface lustre and low susceptibility to wear.[6]

Among all the groups, the results showed that the maximum root mean square value was exhibited by Group -II which was 4.55±0.29 nm^2 and consisted of unpolished IPS Empress Direct, ($P<0.05$), is considered statistically significant. This may be due to the fact that the surface finish of composite resin is dependent on the microstructure and also on the finishing and polishing systems used to modify their surface.[5]

The minimum root mean square value was exhibited by Group-IV(b)which was 0.22±0.02 nm^2 in which IPS Empress Direct was polished with astrobrush , ($P<0.05$), is considered statistically significant. This may be due to the fact that abrasive medium silicon carbide is integrated into the special fibres of the polishers. As the bristles wear down, fresh abrasive medium is released on the surface for better polish.[10] Also Astrobrush does not have a separate finishing procedure before polishing which are more prone to expose the filler particles with preferential loss of the resin matrix.[5]

Among Group-III(a) and IV(a) ,the results showed that the root mean square value exhibited by Group –IV(a) (1.93±0.03 $nm^{2)}$) was more than that

exhibited by Group III(a) (0.92±0.05 nm^2) , (P<0.05), is considered statistically significant . This may be due to the fact that glass fillers present in Tetric evo ceram results in low wear and favorable polishing leading to better surface finish .[65] In a study by Kumari M *et al.,* it was found that Tetric evo ceram showed the least surface roughness among the five polished composites evaluated using atomic force microscope. [64]

Among Group-III(b) and IV(b) ,the results showed that the root mean square value exhibited by Group –III(b) (0.25±0.02 nm^2) was more than that exhibited by Group IV(b) (0.22±0.02 nm^2) , (P>0.05), is considered statistically insignificant. This may be due to the fact that spherical mixed oxide enhances the shine of the material and smoothness of IPS Empress Direct restorative material. Further, the enamel shade contains fine barium glass fillers which impart favourable polishing properties.[6]

Among Group-III(a) and Group III(b) ,the results showed that the root mean square value exhibited by Group –III(a) (0.92±0.05nm^2) was more than that exhibited by Group III(b) (0.25±0.02 nm^2) , (P<0.05), is considered statistically significant. This may be due to the fact that the tungsten carbide incorporated in Astropol was inferior in removing the surface irregularities of resin composites when compared to Silicon carbide incorporated in Astrobrush.[10]

Among Group-IV(a) and Group IV(b) ,the results showed that the root mean square value exhibited by Group –IV(a) (1.93±0.03 nm^2) was more than

that exhibited by Group IV(b) (0.22 ± 0.02 nm^2) , ($P<0.05$), is considered statistically significant. This may be due to the fact that the silicon carbide that is incorporated in Astrobrush (single step polishing system) was more superior in removing the surface irregularities of resin composites when compared to tungsten carbide incorporated in Astropol (multi step polishing system)[5]. However contrary to this , in a study conducted by Ismail Hakku *et al*.,it was found that multistep polishing systems produced lesser surface roughness when compared to single step polishing systems.[60]

One of the most critical aspect of a restorative procedure is to match the colour of the resin composite restoration to the surrounding tooth structure. In this study the results showed that there is very minimal changes in colour values of groups before and after polishing with the two different polishing systems , ($P>0.05$), is considered statistically insignificant. The colour changes in composite at 24 hours may due to post polymerization reaction and that after 1 month may be due to resin water sorption .In this study, very minimal colour changes immediately after polishing may be due to minimal composite post-polymerization reaction [66.] However colour stability may be affected with passage of time. In a study conducted by Leite M *et al.* on the effect of beverages on colour stability, the results showed that after 2 weeks, there were statistically significant changes in colour of composites with the exception of those stored in distilled water.[43] In a study conducted by Baig AR on the effect of mouth rinses on colour stability of composite Tetric N ceram, it was found that there were significant changes in the colour stability when non alcohol

based mouth rinses were used. [63] Another study was done by Taşkınsel E *et al* . On the effects of sports beverages and polishing systems on color stability of different resin composites. Significant differences were found between the colour values of the groups after seven days of immersion.[42]

The use of Astrobrush showed better polishability when compared to Astropol. Astrobrush does not have a separate finishing procedure before polishing. Hence there is less chance for filler particles to get exposed with preferential loss of the resin matrix. Moreover, the silicon carbide that is incorporated in Astrobrush was more superior in removing the surface irregularities of resin composites when compared to tungsten carbide incorporated in Astropol.[5]

The presence of irregularities in composites can influence appearance, plaque retention, surface discoloration and gingival inflammation .In addition, the surface roughness of composites can reduce the hardness and increase the wear of these restorations. So the esthetics and longevity of restorations strongly depend on the quality of the surface finishing and polishing. [27.]Hence this study was done to assess the superiority of the polishing systems which may provide better finishing and polishing of the nanocomposites.

However this study has its own limitations. Only two nanocomposites were used in this study. Hence newer modified nanocomposites need to be evaluated to come to an appropriate conclusion on its surface roughness and colour stability. Furthermore, only two polishing systems were examined. Several other composite polishing systems need to be evaluated. In this study

the surface roughness immediately after polishing was evaluated. But the effect of the masticatory forces as well as the influence of food substances and fluids on surface roughness need to be evaluated in the long term. In this study only the immediate colour stability before and after polishing were evaluated .The composites may change colour with the passage of time due to exposure to various food substances and fluids .Hence the long term colour stability of these composites need to be evaluated.

SUMMARY & CONCLUSION

The recent improvements and advances in the field of esthetic dentistry, newer materials and the esthetic demands of patients have often led to the increase in frequency of use of composite restorations in dentistry. There are different types of composite material available for restoration. The success of a composite restoration depends ultimately on its esthetics and longevity. The surface roughness is one of the most common parameter used to assess the smoothness of the surface of restoration .With increased surface finish comes better physical properties and wear resistance.A better surface finish also reduces plaque accumulation and abrasivity . A good surface finish also reduces patient discomfort in terms of tactile perception.They also give these restorations better esthetic appearance .

Developments in the field of nanotechnology has been put to good use in dentistry.Thus the emergence of nanocomposite restorative materials. There are several nanocomposite restorative materials available in the market today .These nanocomposite restorative materials have better properties when compared with conventional composite materials.

This study was done to evaluate the surface roughness and immediate colour stability of two nanocomposites - Tetric evo ceram and IPS Empress Direct when polished with two different polishing systems - Astropol and Astrobrush .

Orthodontic bands of thickness 0.006 inches were used to make cylindrical metallic moulds of the dimensions 10mm diameter and 6 mm

height . The cylindrical metallic mould was placed vertically on a flat glass surface. . Then the composite material was placed in increments of 2mm or less and packed into the cylindrical metallic mould using a teflon coated composite placement instrument . A transparent matrix strip was applied on top of each increment of composite with a constant pressure to extrude excess material ,to flatten the surface and to reduce voids at the surface. Each increment of composite were light cured for 40 seconds using LED light curing unit. of intensity 400 milli watts/ cm^2 . Following complete curing of the composite ,the metallic moulds were separated using a scalpel to obtain cylindrical composites of the specified dimensions. Colour stability of the flat surfaces were evaluated before polishing using spectrophotometer . The specimens were randomnly divided into six groups of ten specimens each . Each of the flat surfaces of the samples were polished unidirectionally(four strokes each) for eight seconds each using the two different polishing systems,

1 .Astropol with its finishing grit, polishing grit and high gloss polishing grit respectively. 2.Astrobrush at low speed using a micro motor hand piece. Immediate colour stability was evaluated after polishing using spectrophotometer. The cylindrical composite specimens were placed in normal saline before evaluating the flat surfaces for surface roughness using AFM.

The results showed that among the experimental groups the maximum root mean square value of 1.93±0.03 nm^2 was observed for group IV(a) [Tetric

evo ceram polished with astropol] when compared to groups Group-III(a), Group-III(b), Group-IV(b), ($P<0.05$), is considered statistically significant.

The minimum root mean square value of 0.22 ± 0.02 nm^2 was observed for Group-IV(b) [IPS Empress Direct polished with Astrobrush] when compared to Groups - III (a), III (b), IV (a) , ($P<0.05$), is considered statistically significant.

The results showed that there is very minimal changes in colour values of groups before and after polishing with the two different polishing systems , ($P>0.05$), is considered statistically insignificant.

Hence within the limitations of this *in vitro* study it may be concluded that a superior polish was obtained when the composites were polished with astrobrush when compared to those polished with astropol. There was very minimal difference in the colour stability of these composites before and after polising using the two different polishing systems.

TABLES

Tables

Table -1: Root mean square value (nm^2) of samples of groups

Samples	Group I	Group II	Group III(a)	Group III(b)	Group IV(a)	Group IV(b)
I	2.76	4.53	0.92	0.25	1.94	0.22
2	2.71	4.28	0.87	0.21	1.90	0.26
3	2.77	4.75	0.97	0.23	1.92	0.24
4	2.72	4.92	0.95	0.21	1.93	0.21
5	2.80	4.81	0.98	0.28	1.97	0.27
6	2.76	4.94	0.96	0.29	1.90	0.23
7	2.73	4.36	0.90	0.27	1.92	0.24
8	2.79	4.54	0.82	0.25	1.96	0.21
9	2.75	4.11	0.87	0.26	1.94	0.22
10	2.81	4.29	0.96	0.25	1.99	0.19

Table-2: Mean root mean square value(nm^2) of different groups

Groups	Mean root mean square values (RMS) (nm^2) (MEAN±SD)
Group-I	2.76±0.03
Group-II	4.55±0.29
Group-III (a)	0.92±0.05
Group-III (b)	0.25±0.02
Group- IV (a)	1.93±0.03
Group-IV (b)	0.22±0.02

Table-3: Comparison of mean root mean square value(nm^2) of Group-I with other groups

Groups	Mean root mean square values (RMS) (nm^2) (MEAN±SD)	P value
Group-I	2.76±0.03	
Group-II	4.55±0.29*	**<0.05**
Group-III (a)	0.92±0.05*	**<0.05**
Group-III (b)	0.25±0.02*	**<0.05**
Group- IV (a)	1.93±0.03*	**<0.05**
Group-IV (b)	0.22±0.02*	**<0.05**

(*P<0.05 significant compared Group-I with other groups)

Table-4: Comparison of mean root mean square value(nm^2) of Group-II with other groups

Groups	Mean root mean square values (RMS) (nm^2) (MEAN±SD)	P value
Group-II	4.55±0.29	
Group-I	2.76±0.03*	**<0.05**
Group-III (a)	0.92±0.05*	**<0.05**
Group-III (b)	0.25±0.02*	**<0.05**
Group- IV (a)	1.93±0.03*	**<0.05**
Group-IV (b)	0.22±0.02*	**<0.05**

(*P<0.05 significant compared Group-II with other groups)

Table-5: Comparison of mean root mean square value(nm^2) of Group-III (a) with other groups

Groups	Mean root mean square values (RMS) (nm^2) (MEAN±SD)	P value
Group-III (a)	0.92±0.05	
Group-I	2.76±0.03*	**<0.05**
Group-II	4.55±0.29*	**<0.05**
Group-III (b)	0.25±0.02*	**<0.05**
Group- IV (a)	1.93±0.03*	**<0.05**
Group-IV (b)	0.22±0.02*	**<0.05**

(*P<0.05 significant compared Group-III (a) with other groups)

Table-6: Comparison of mean root mean square value(nm^2) of Group-III (b) with other groups

Groups	Mean root mean square values (RMS) (nm^2) (MEAN±SD)	P value
Group-III (b)	0.25±0.02	
Group-I	2.76±0.03*	**<0.05**
Group-II	4.55±0.29*	**<0.05**
Group-III (a)	0.92±0.05*	**<0.05**
Group- IV (a)	1.93±0.03*	**<0.05**
Group-IV (b)	0.22±0.02	**>0.05**

(*P<0.05 significant compared Group-III (b) with other groups)

Table-7: Comparison of mean root mean square value(nm^2) of Group-IV (a) with other groups

Groups	Mean root mean square values (RMS) (nm^2) (MEAN±SD)	P value
Group- IV (a)	1.93±0.03	
Group-I	2.76±0.03*	**<0.05**
Group-II	4.55±0.29*	**<0.05**
Group-III (a)	0.92±0.05*	**<0.05**
Group-III (b)	0.25±0.02*	**<0.05**
Group-IV (b)	0.22±0.02*	**<0.05**

(*P<0.05 significant compared Group-IV (a) with other groups)

Table-8: Comparison of mean root mean square value(nm^2) of Group-IV (b) with other groups

Groups	Mean root mean square values (RMS) (nm^2) (MEAN±SD)	P value
Group-IV (b)	0.22±0.02	
Group-I	2.76±0.03*	**<0.05**
Group-II	4.55±0.29*	**<0.05**
Group-III (a)	0.92±0.05*	**<0.05**
Group-III (b)	0.25±0.02	**>0.05**
Group- IV (a)	1.93±0.03*	**<0.05**

(*P<0.05 significant compared Group-IV (b) with other groups)

Table-9: Multiple comparison of mean root mean square value(nm^2) between the groups

Groups	Mean root mean square values (RMS) (nm^2) (MEAN±SD)	Comparison	P value
Group-I	2.76±0.03	**I with II, III (a), III (b), IV (a), IV (b)**	**<0.05**
Group-II	4.55±0.29*	**II with I, III (a), III (b), IV (a), IV (b)**	**<0.05**
Group-III (a)	0.92±0.05*,#	**III (a) with I, II, III (b), IV (a), IV (b)**	**<0.05**
Group-III (b)	0.25±0.02*,#,$	**III (b) with I, II, III (a), IV (a)**	**<0.05**
Group- IV (a)	1.93±0.03*,#,$,¶	**IV (a) with I, II, III (a), III (b), IV (b)**	**<0.05**
Group-IV (b)	0.22±0.02*,#,$,ǁ	**IV (b) with I, II, III (a), IV (a)**	**<0.05**

(*P<0.05 significant compared Group-I with other groups, #P<0.05 significant compared Group-II with other groups, $P<0.05 significant compared Group-III (a) with other groups, ¶P<0.05 significant compared Group-III (b) with other groups, ǁP<0.05 significant compared Group-IV (a) with other groups)

Table-10: Comparison of mean root mean square value(nm^2) of Group-III (a) with Group-III (b)

Groups	Mean root mean square values (RMS) (nm^2) (MEAN±SD)	P value
Group-III (a)	0.92±0.05	**<0.05**
Group-III (b)	0.25±0.02*	

(*P<0.05 significant compared Group-III (a) with Group-III (b))

Table-11: Comparison mean root mean square value(nm^2) of Group-IV (a) with Group-IV (b)

Groups	Mean root mean square values (RMS) (nm^2) (MEAN±SD)	P value
Group-IV (a)	1.93±0.03	**<0.05**
Group-IV (b)	0.22±0.02*	

(*P<0.05 significant compared Group-IV (a) with Group-IV (b))

Table-12: Colour value(nm) of samples of groups before polishing

Samples	Group I	Group II	Group III(a)	Group III(b)	Group IV(a)	Group IV(b)
I	3.871	4.886	5.929	4.963	5.311	3.973
2	3.894	4.823	5.926	4.960	5.307	3.971
3	3.851	4.943	5.932	4.966	5.315	3.975
4	3.884	4.862	5.927	4.962	5.316	3.972
5	3.876	4.902	5.931	4.964	5.306	3.974
6	3.861	4.925	5.923	4.961	5.314	3.977
7	3.882	4.844	5.935	4.965	5.308	3.969
8	3.833	4.856	5.925	4.967	5.310	3.966
9	3.915	4.912	5.933	4.959	5.312	3.980
10	2.81	4.886	5.929	4.963	5.311	3.973

Table-13: Colour value(nm) of samples of groups after polishing

Samples	Group I	Group II	Group III(a)	Group III(b)	Group IV(a)	Group IV(b)
I	3.879	4.881	5.922	4.961	5.316	3.972
2	3.898	4.824	5.924	4.963	5.304	3.976
3	3.856	4.945	5.936	4.961	5.312	3.971
4	3.882	4.867	5.924	4.969	5.314	3.979
5	3.879	4.903	5.932	4.966	5.303	3.977
6	3.864	4.929	5.924	4.964	5.317	3.971
7	3.887	4.845	5.935	4.969	5.309	3.963
8	3.835	4.852	5.925	4.962	5.315	3.964
9	3.919	4.915	5.936	4.954	5.311	3.986
10	2.812	4.887	5.928	4.962	5.312	3.972

Table-14: Mean color value(nm) before polishing of different groups

Groups	Mean color value (nm) before polishing (MEAN±SD)
Group-I	3.76±0.33
Group-II	4.88±0.03
Group-III (a)	5.92±0.03
Group-III (b)	4.96±0.02
Group- IV (a)	5.31±0.01
Group-IV (b)	3.97±0.01

Table-15: Mean color value(nm) after polishing of different groups

Groups	Mean color value (nm) after polishing (MEAN±SD)
Group-I	3.77±0.33
Group-II	4.88±0.03
Group-III (a)	5.92±0.01
Group-III (b)	4.96±0.04
Group- IV (a)	5.31±0.04
Group-IV (b)	3.97±0.01

Table-16: Comparison of mean color value(nm) before and after polishing within the groups

Groups	Mean color value (nm) before polishing (MEAN±SD)	Mean color value (nm) after polishing (MEAN±SD)	P value
Group-I	3.76±0.33	3.77±0.33	**>0.05**
Group-II	4.88±0.03	4.88±0.03	**>0.05**
Group-III (a)	5.92±0.03	5.92±0.01	**>0.05**
Group-III (b)	4.96±0.02	4.96±0.04	**>0.05**
Group- IV (a)	5.31±0.01	5.31±0.04	**>0.05**
Group-IV (b)	3.97±0.01	3.97±0.01	**>0.05**

(P>0.05 no significant difference within the groups before and after polishing)

FIGURES

Figure 1:Composites used in the study(Tetric evo ceram and IPS Empress Direct).

Figure 2: Polishing systems used for the Study (AstroPol and Astrobrush).

Figure 3 : Moulds made for packing composites .(Dimensions - thickness 0.006 inches ,10mm diameter and 6 mm height)

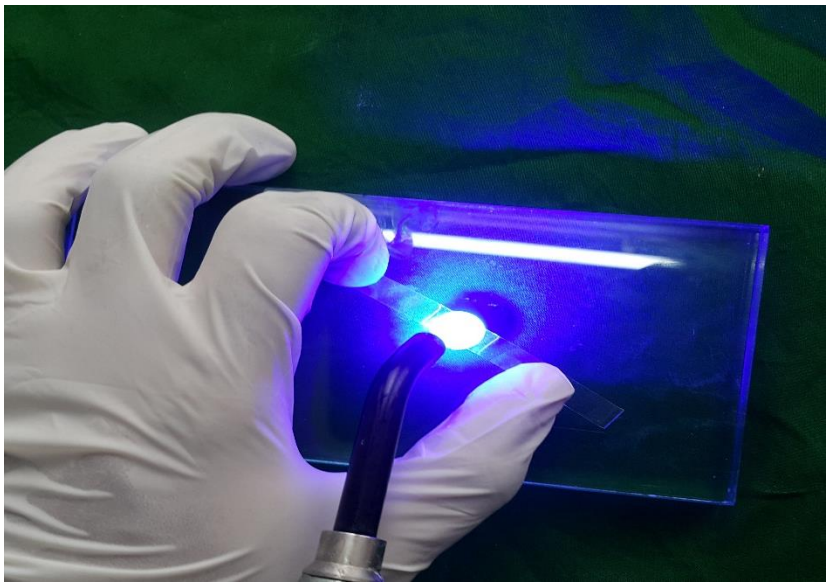

Figure 4: The composites packed and light cured.(LED Light curing unit).

Figure 5(a):Composite polished with AstroPol

Figure 5(b):Composite polished with Astrobrush

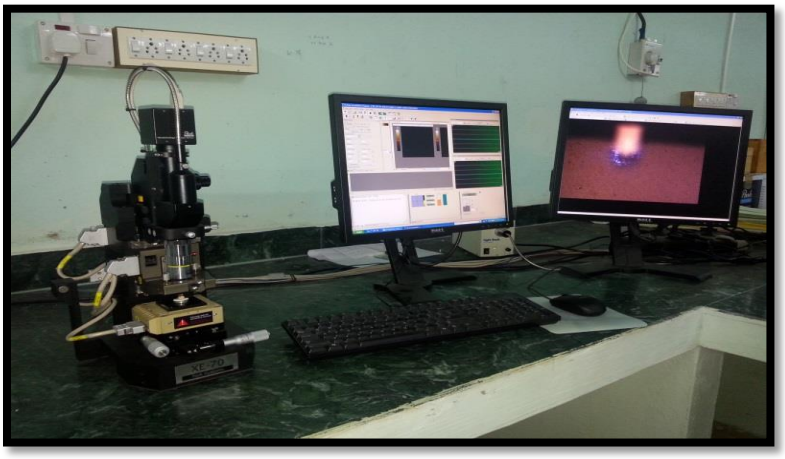

Figure 6: Atomic Force Microscope analysis of samples

Figure 7: Spectrophotometer analysis of samples

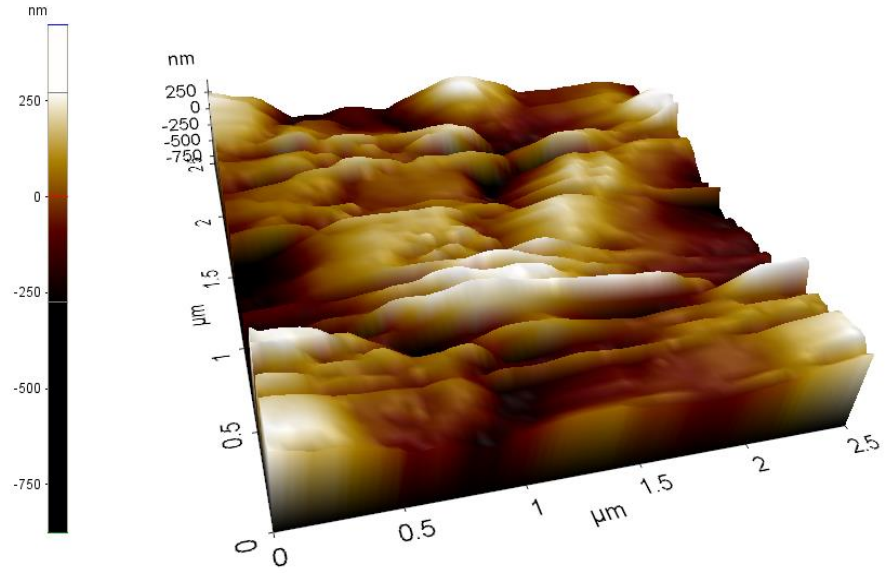

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Figure 8: 3D image of group I

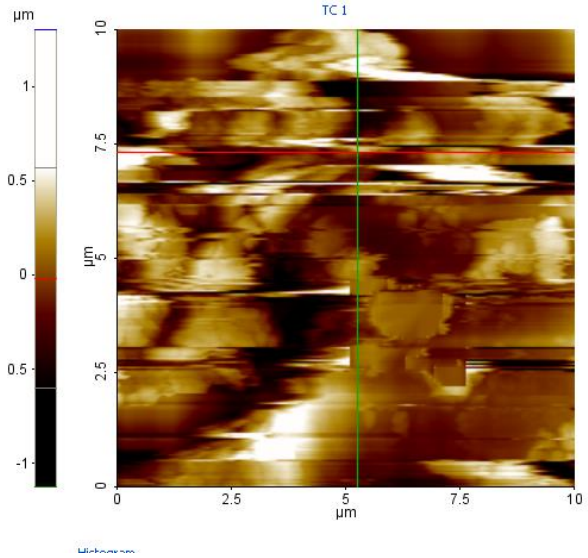

Figure 9: 2D image of group I

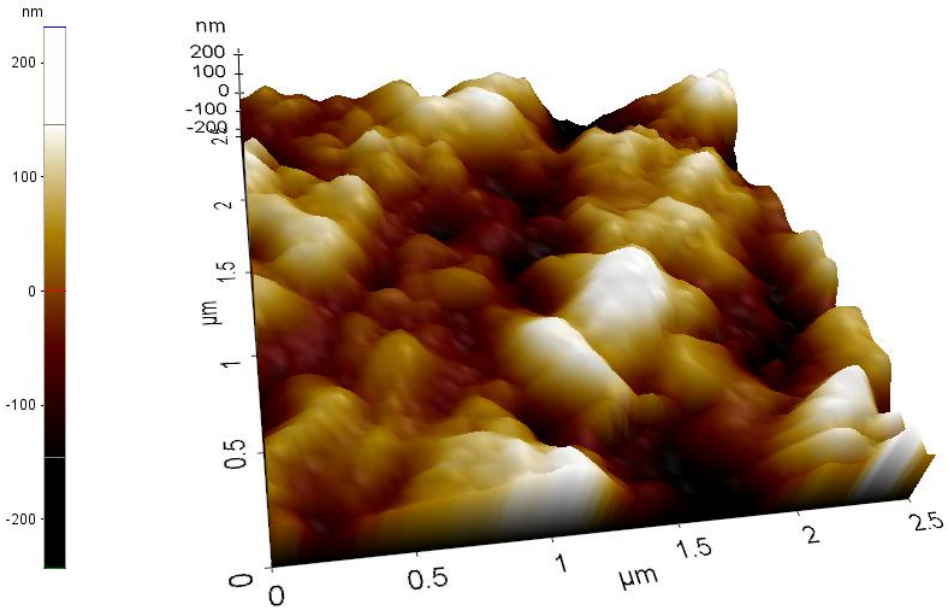

Figure 10: 3D image of group II

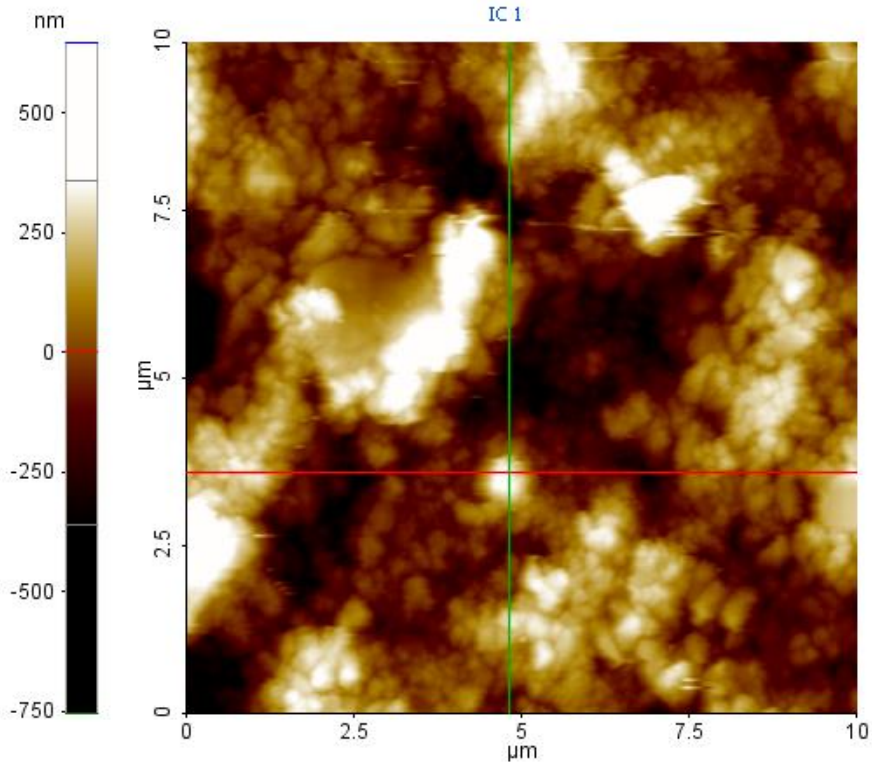

Figure 11: 2D image of group II

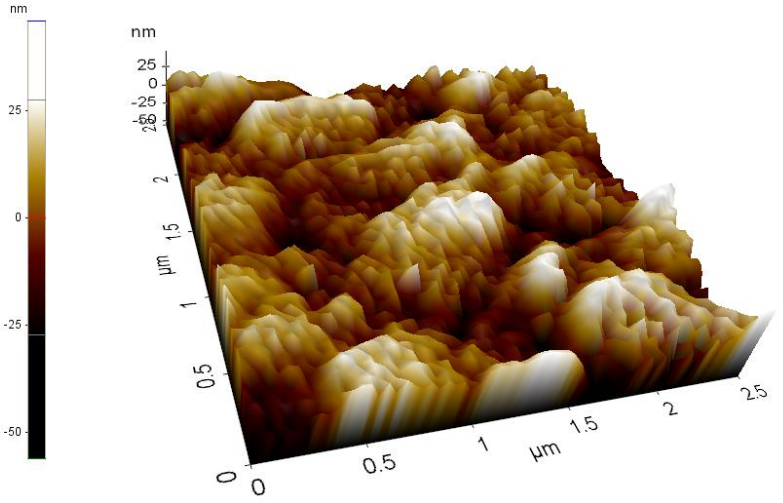

Figure 12: 3D image of group III(a)

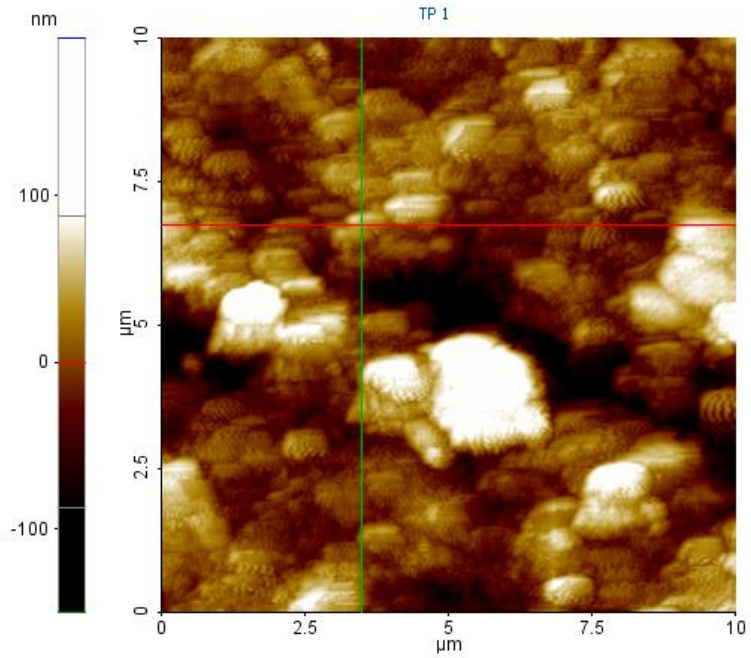

Figure 13: 2D image of group III(a)

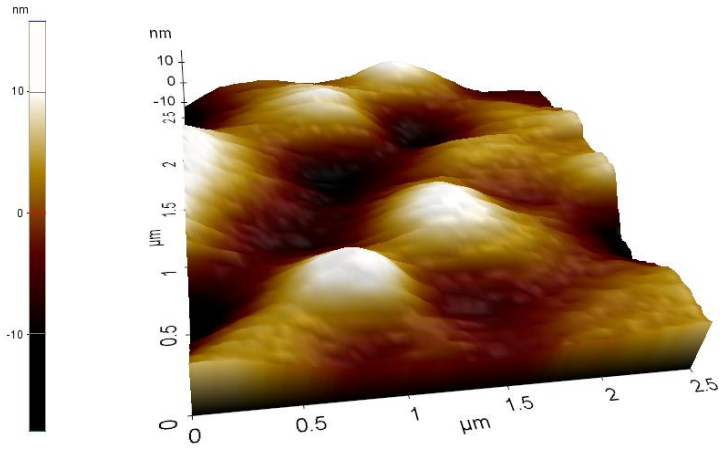

Figure 14: 3D image of group III(b)

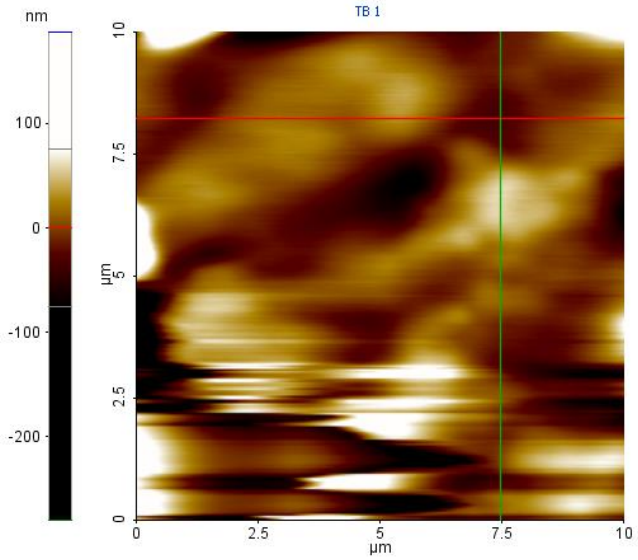

Figure 15: 2D image of group III(b)

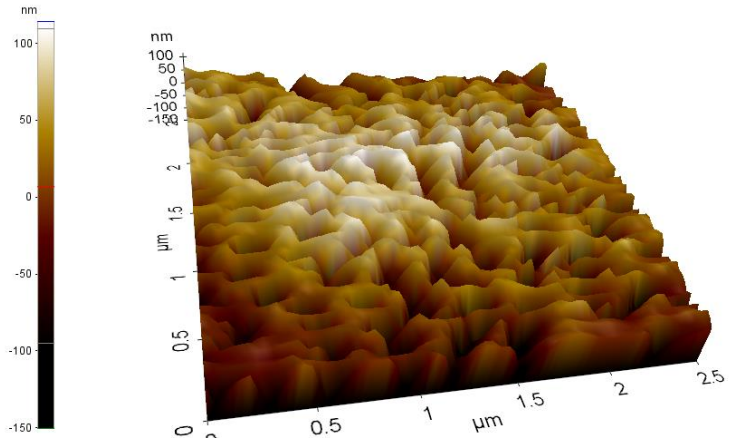

Figure 16: 3D image of group IV(a)

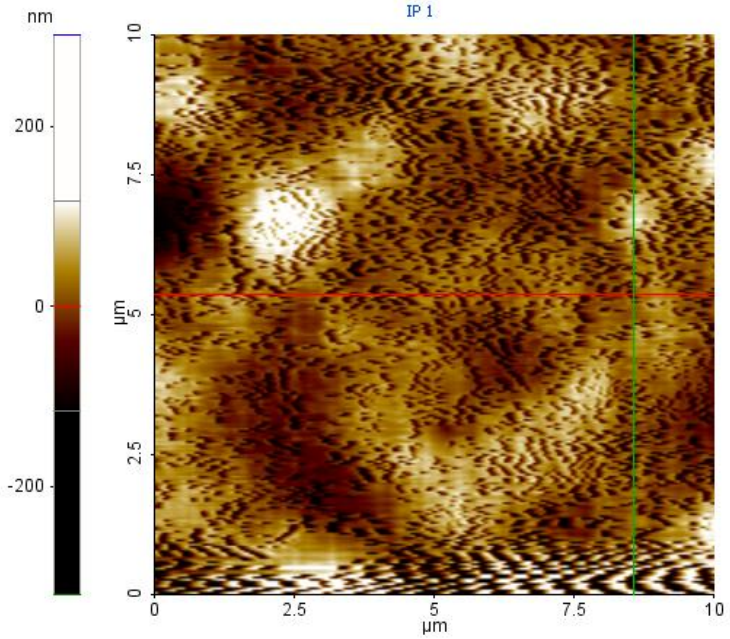

Figure 17: 2D image of group IV(a)

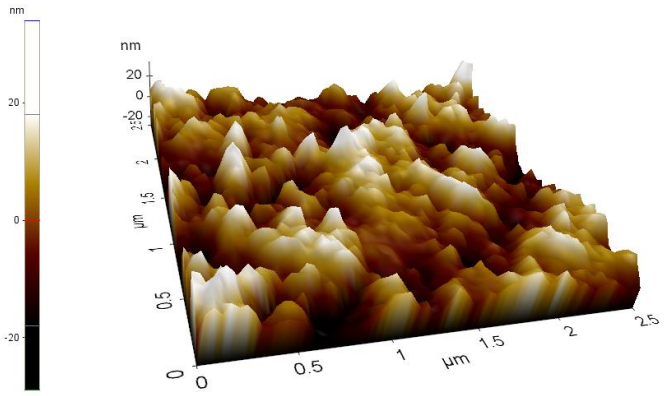

Figure 18: 3D image of group IV(b)

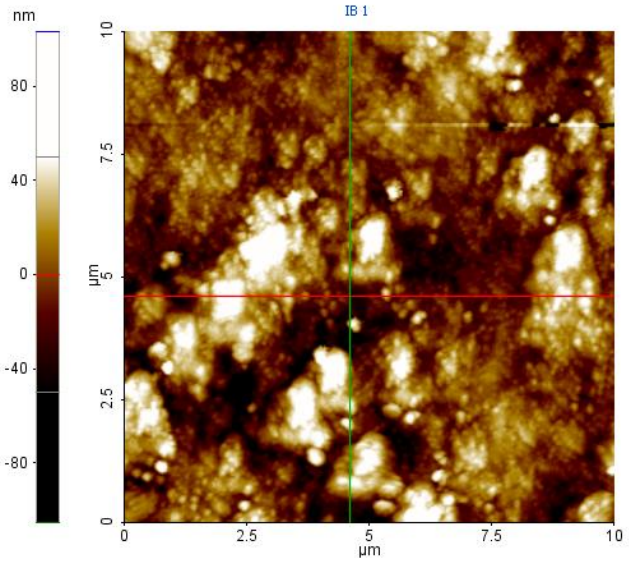

Figure 19: 2D image of group IV(b)

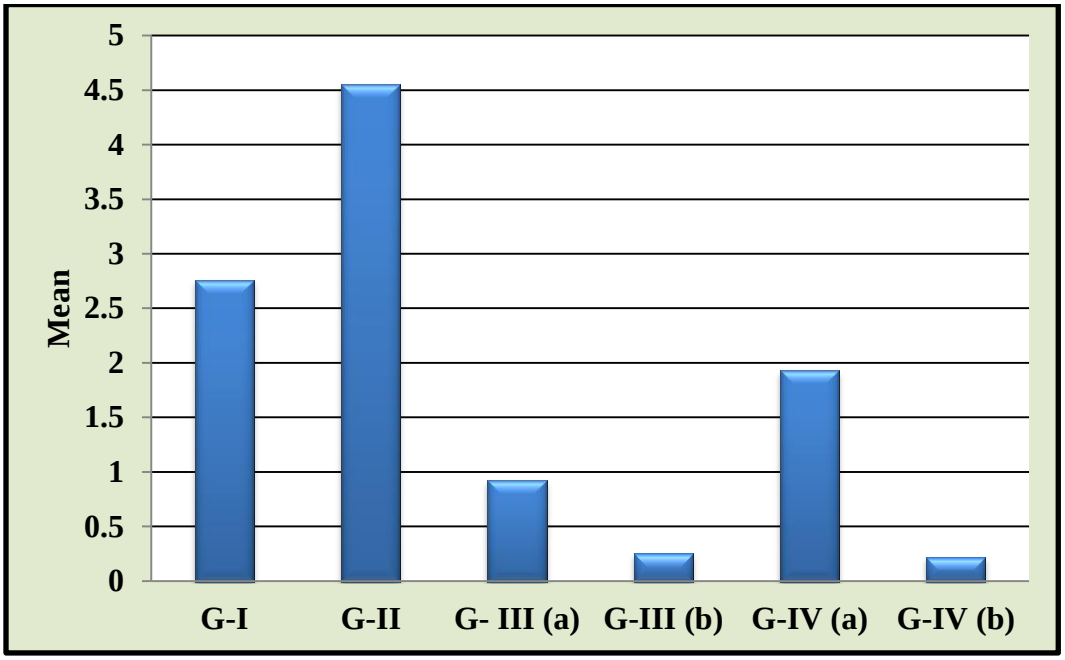

Figure 20: Mean root mean square value(nm^2) of different groups

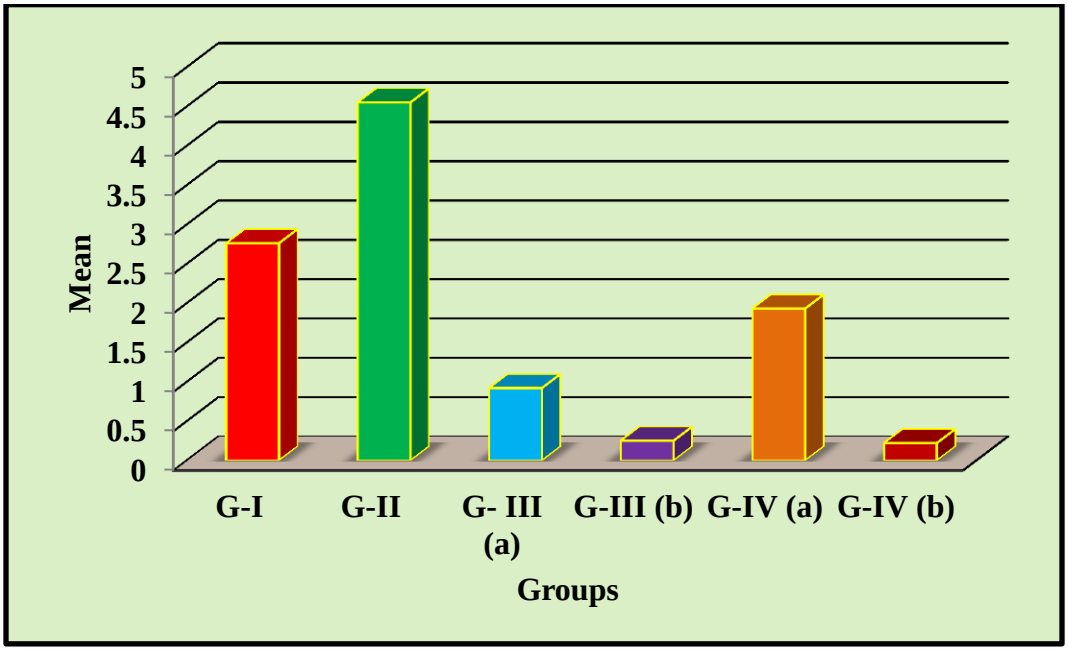

Figure 21: Comparison of mean root mean square value(nm^2) of Group-I with other groups

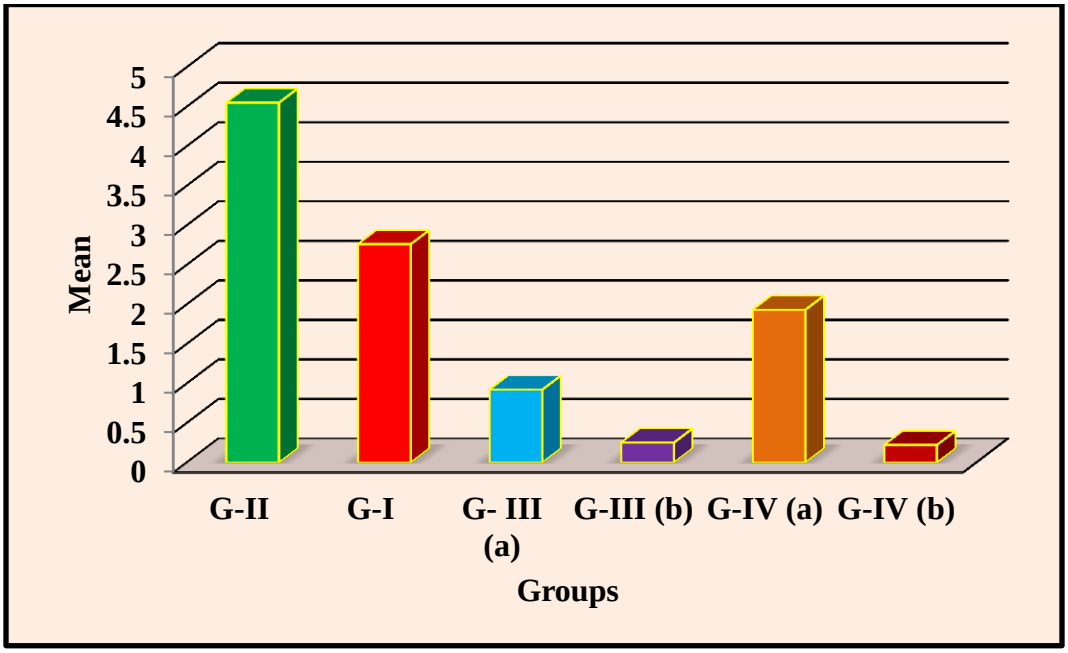

Figure 22: Comparison of mean root mean square value(nm^2) of Group-II with other groups

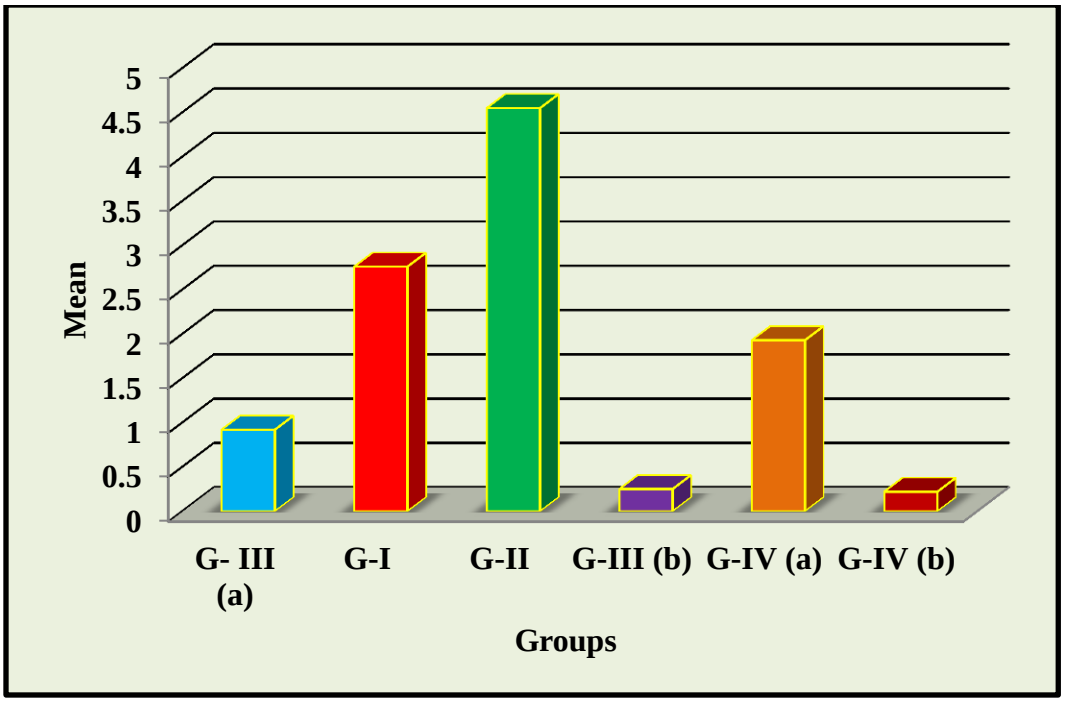

Figure 23 : Comparison of mean root mean square value(nm^2) of Group-III (a) with other groups

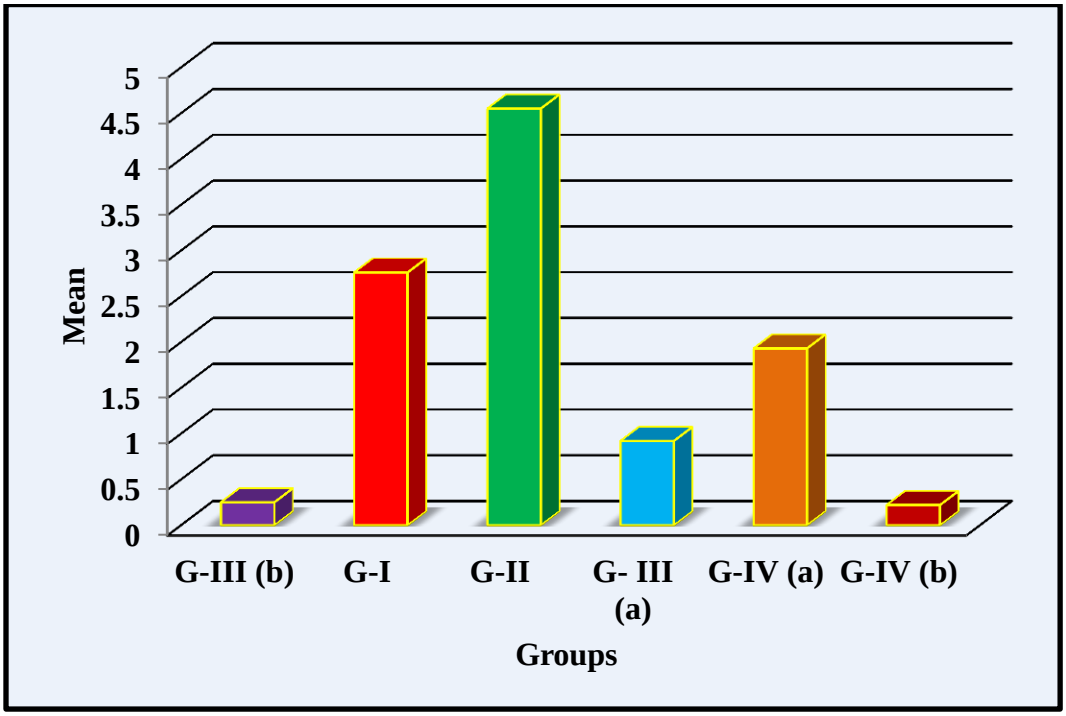

Figure 24: Comparison of mean root mean square value(nm^2) of Group-III (b) with other groups

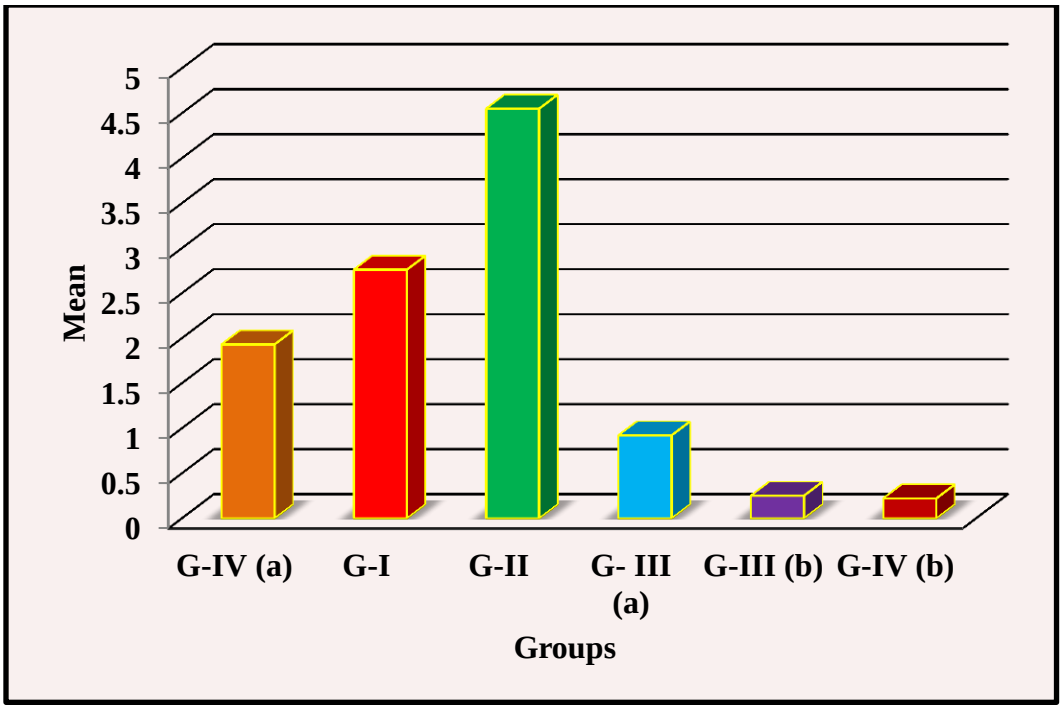

Figure 25: Comparison of mean root mean square value(nm^2) of Group-IV (a) with other groups

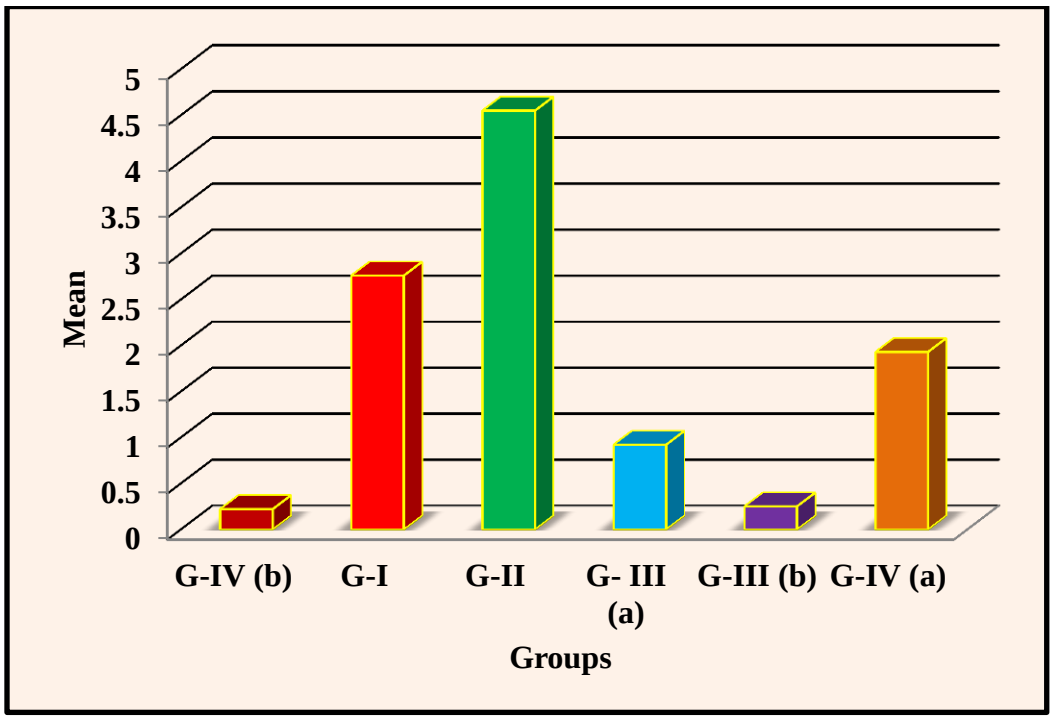

Figure 26 : Comparison of mean root mean square value(nm^2) of Group-IV (b) with other groups

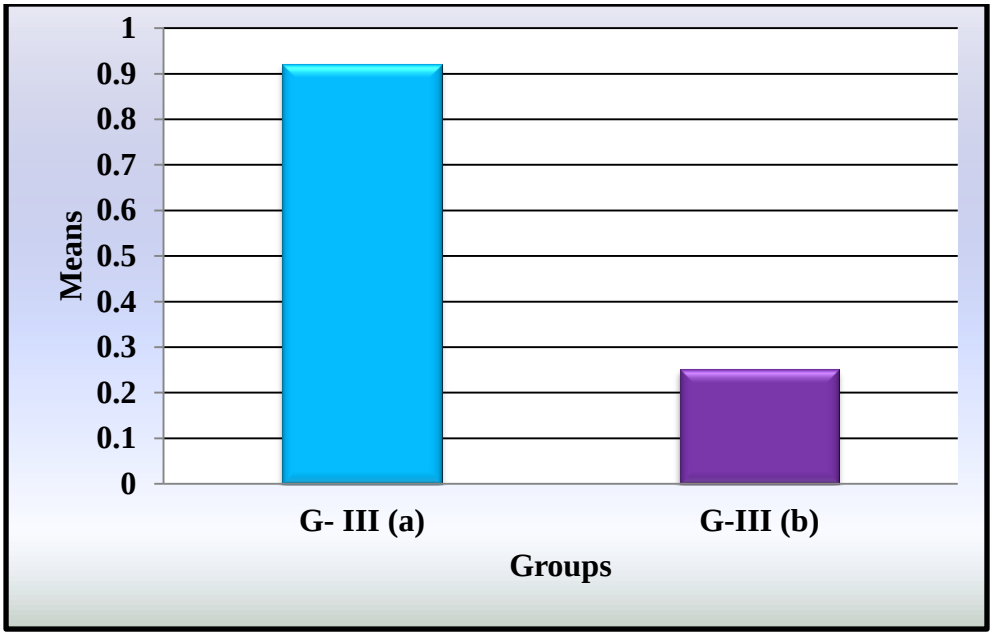

Figure 27 : Comparison mean root mean square value(nm^2) of Group-III (a) with Group-III (b)

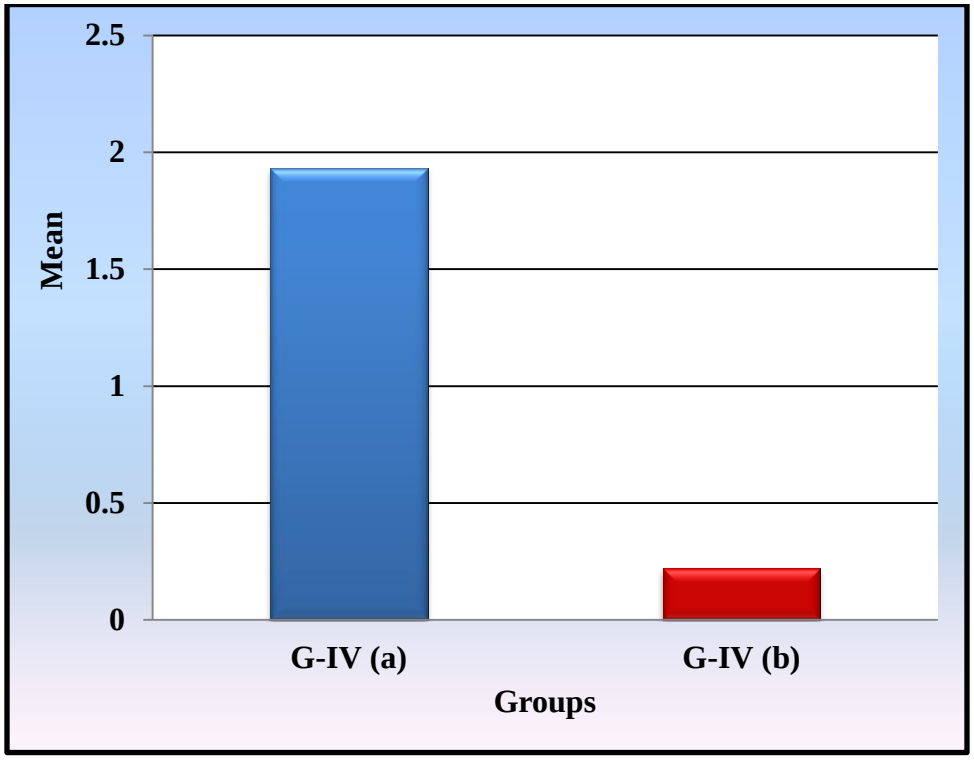

Figure 28 : Comparison mean root mean square value(nm^2) of Group-IV (a) with Group-IV (b)

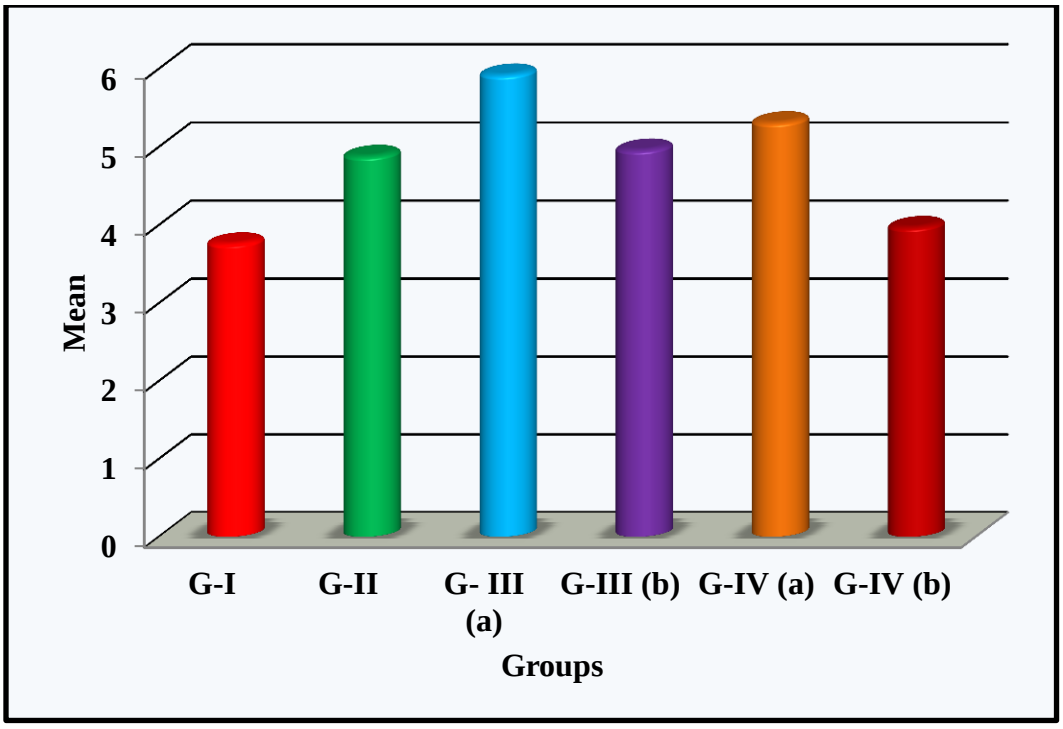

Figure 29: Mean color value(nm) before polishing of different groups

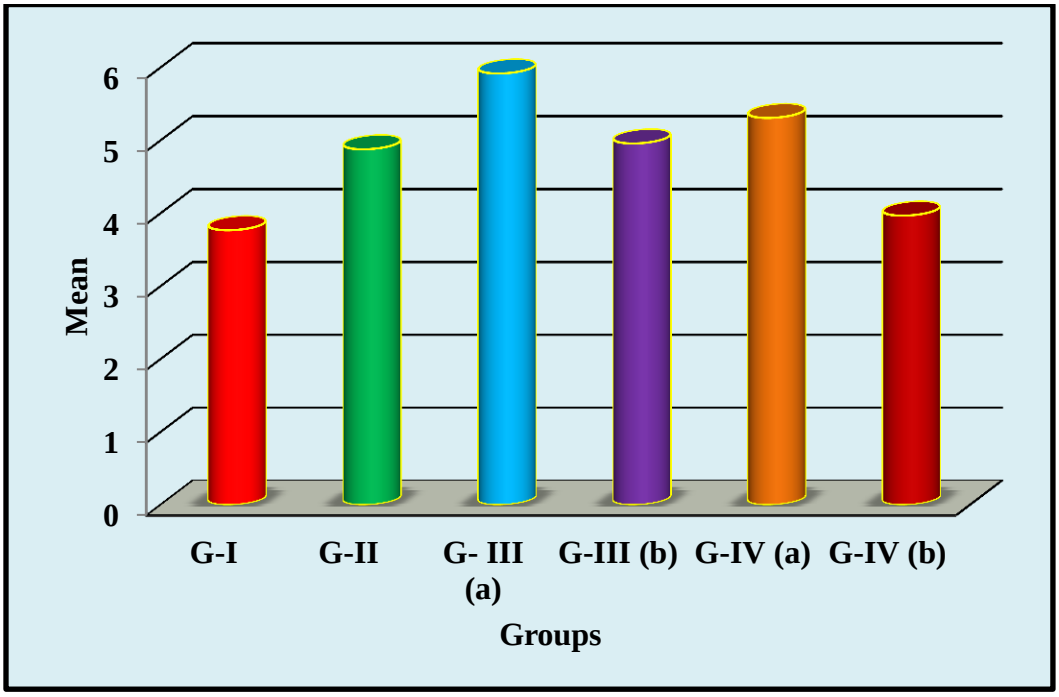

Figure 30 : Mean color value(nm) after polishing of different groups

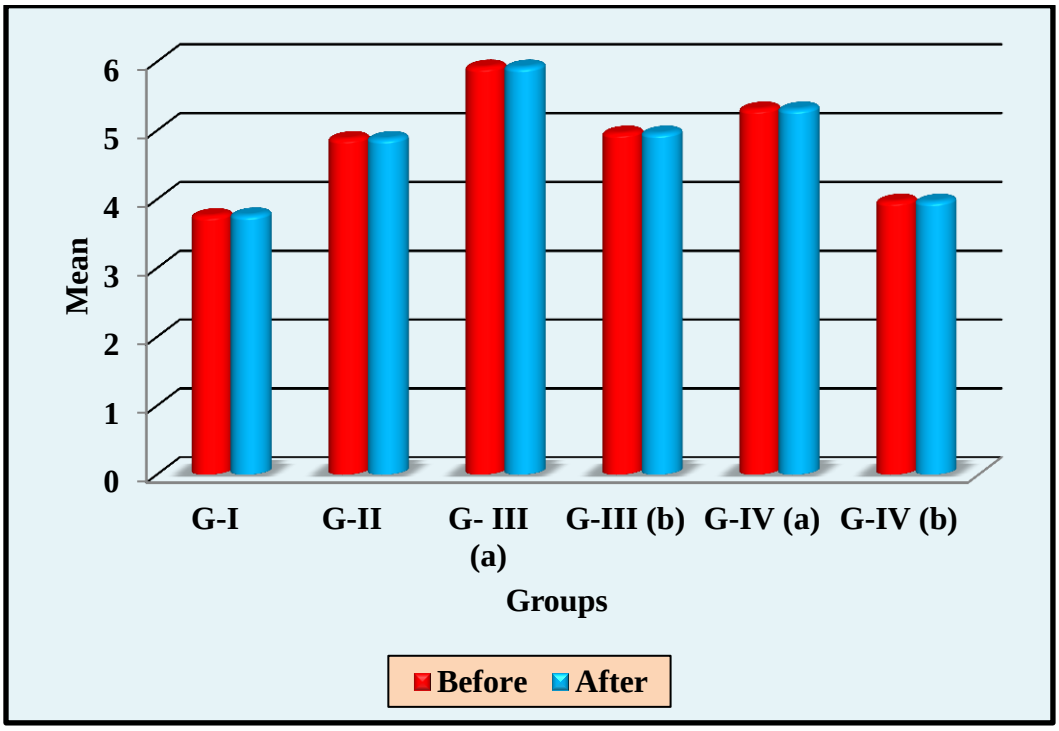

Figure 31: Comparison of mean color value(nm) before and after polishing within the groups.

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